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AUGUST 1934

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CORRECTION

Volume 62, June 1934, page 194, in table 2 the heading of the fourth column should be: "$V_s - V_o$".

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AUGUST 1934

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A CLIMATOLOGICAL REVIEW OF THE ALASKA-YUKON PLATEAU

By R. L. FROST

[Weather Bureau office, Fairbanks, Alaska, July 1934]

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INTRODUCTORY

Along the western edge of North America the Pacific Mountain system extends in an unbroken chain from Lower California to Attu Island. This great mountain system includes the Sierra Nevada of California, the Cascades of Oregon and Washington, and the Coast Range of British Columbia. In Yukon Territory and Alaska they are known by a number of names in different localities and include the Chugach Range, the Saint Elias Range, the Wrangell Mountains, the Alaska Range, and the Aleutian Range. Here are found the loftiest and most rugged mountains on the continent; Mount McKinley, the highest, being 20,300 feet. The glaciers of this region contain a greater amount of ice than the total of all others in the world, outside of Greenland and the Antarctic. Muir Glacier alone is greater than the 1,100 Swiss glaciers combined.

In the interior, and roughly paralleling the coast, the great Rocky Mountain chain extends the entire length of the continent. In Alaska these are known as the Endicott Mountains and are said to be the least known of any in North America. Extensive areas still remain unexplored. A bold headland at Cape Lisburne marks the westernmost limit of this great mountain system.

Between the Pacific Range and the Rocky Mountain chain is located a high semiarid plateau, varying greatly in width and gradually decreasing in altitude from the highlands of Nevada northward until the coast of Bering Sea is reached. Four river systems provide drainage for this region. The Colorado in the south, the Columbia and the Frazier near the center, and the Yukon in the far north. These streams possess individual features that make them unique. The Colorado is noted for the Grand Canyon. The Frazier and the Columbia are among the few rivers of the world that have cut out passages through a main range of mountains. The Yukon River flows between the two mountain systems much as the Colorado does at the southern end of the great inland plateau. However, the Yukon possesses several characteristics that are exceptionally interesting. The source of this great stream is only 25 miles from the coast, yet the water must travel 2,300 miles to reach the sea. The level tundra land near the mouth of the stream is so low that the 4-foot tides of Norton Sound are noticed at Andreafsky 120 miles inland. For about 6½ months of the year the river is frozen over. The spring break-up usually occurs during the second week of May and soon thereafter the river is clear of ice. However, ice in Bering Sea sometimes remains until the latter part of June and Lake LeBarge near the source of the river is not free of ice until about 3 weeks after the stream opens. Hence, for a few weeks after the spring break-up, the river is open to navigation for 2,000 miles of its course, and yet it is closed at its source and closed at its mouth.

In the United States and southern Canada the great plateau region was fairly well explored early in the nineteenth century and in a comparatively few years became crossed by railroads and dotted with settlements. How different were conditions in the far north! Alaska was discovered in 1741 and for more than a century the Russians devoted their time and energy to the lucrative fur trade of the coastal areas. Long after the first transcontinental railway had ended the covered wagon days on the Oregon Trail and the frontier villages of the west were developing into important commercial centers, the great interior region of Alaska remained virtually unknown. Traders of the Hudson Bay Co. drifted down the Yukon River and in 1847 established a post at Fort Yukon. For years this remote outpost of England was the only white settlement in the interior, a region as large as the State of California. Nearly two centuries have elapsed since white people first came to Alaska and for 67 years the country has been a possession of the United States, yet the mass of the public is profoundly ignorant of its climatic features. During the Russian

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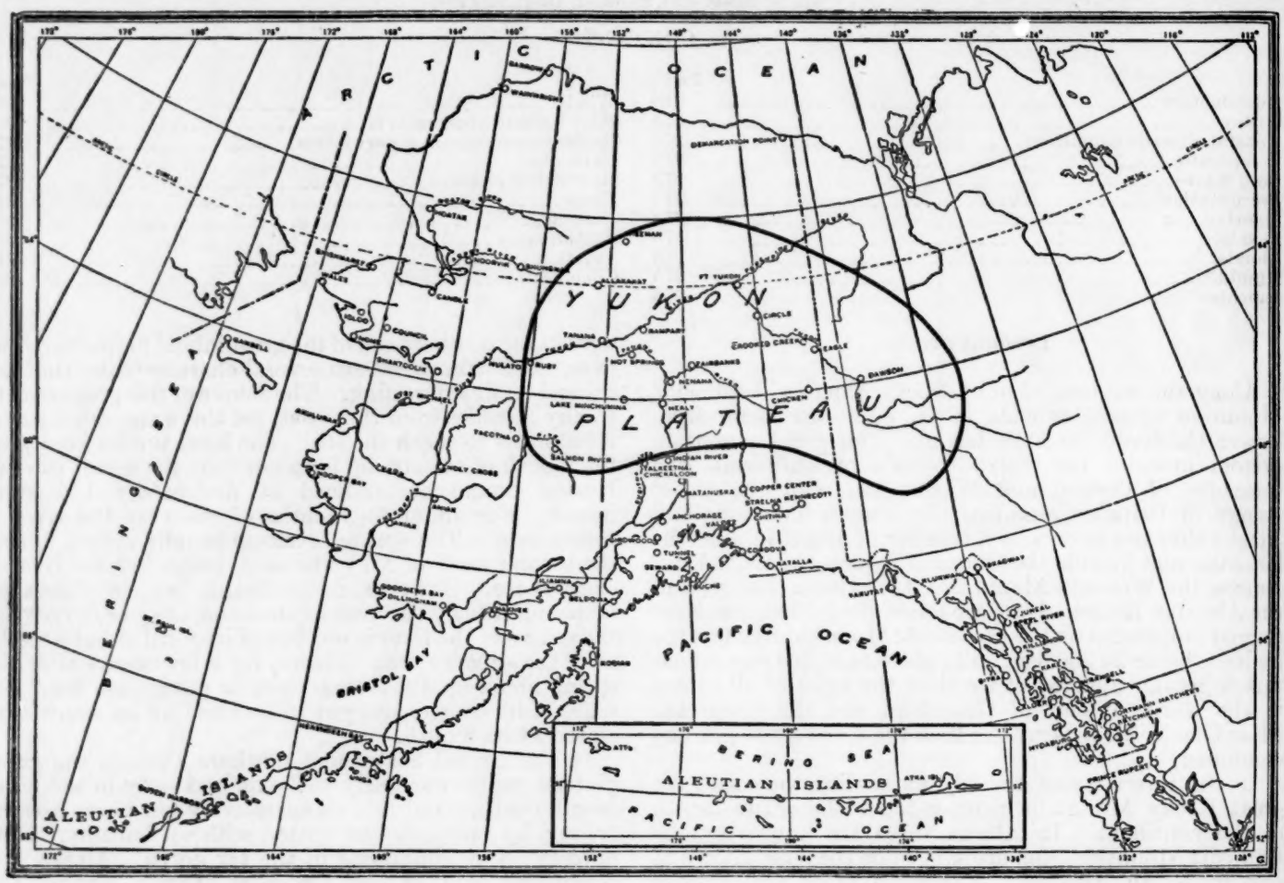
occupation and for 30 years of American rule almost no effort was made to record accurate meteorological observations in the interior. The United States Weather Bureau was organized[1] in 1870 and soon thereafter a few stations were established in Alaska. These were all located along the coast and records of the interior were dependent on more or less incomplete data gathered by explorers and survey parties. The most important of these were: the Western Union Telegraph Expedition of 1865–67, the Coast and Geodetic Survey parties sent out in 1880 and 1891 to determine the intersection of the one hundred and forty-first meridian with the Yukon River, and the Geological Survey expeditions of 1898–1903. Fort Yukon was found to be in Alaska and in 1869 the Hudson Bay post was moved up the Porcupine River into Yukon Territory. The first American settlement in interior Alaska was Circle City founded in 1893. Gold was discovered in nearby streams and the population of Circle City soon reached 10,000. The miners proudly acclaimed it the largest log cabin city in the world.



The plateau section of Alaska and Yukon Territory lies principally between 61° and 67° north latitude and extends westward to the Kokrine Hills and the Kuskokwim Mountains in 155° west longitude. The area included covers about 150,000 square miles and the present population probably does not exceed 10,000. Along the southern margin are the loftiest and most rugged mountains to be found in North America, while to the north are the little known Endicott Mountains. From the Alaska Range on the south to the Tanana River is located the level Tanana Valley. This valley has an area of about 24,000 square miles, equal to the State of West Virginia, and resembles very much the flat prairie regions of the Middle Western States. In a milder climate it would be dotted with farms and villages and perhaps supporting a population of 1,000,000. But it is now wholly uninhabited except for a few mining communities along the northern border. As is true with practically all of interior Alaska the valley is composed of small sluggish streams and marshes and niggerhead swamps interspersed with thickets of willow, alder and scrub spruce forests. Between the Tanana and the Yukon Rivers lie the Tanana Hills, a rough region with gentle rolling hills and domes reaching a maximum altitude of 5,000 feet. The valleys contain fairly good stands of timber consisting of spruce, tamarack, birch, and poplar. Where trees are absent their place is taken by thickets of willow and alder while almost everywhere may be found clumps of cranberry and blueberry bushes. As timberline at this latitude is about 2,500 feet above sea level the summits of practically all the hills are bare of trees but are covered with a dense growth of moss and grass and a great abundance of wild flowers. The Yukon Valley lies just north of the Tanana Hills and is mostly a region of low rolling hills. An exception to this, however, is a region below Circle known as the Yukon Flats. Here the river spreads out into many channels until its extreme width is about 15 miles. The great stream is ever changing its course and wearing new channels in the frozen ground until the territory included in "The Flats" is a maze of channels, sloughs, and swamps. This enormous swamp has an area of about 10,000 square miles or approxi-

[1] As a weather service under the Signal Corps.

mately the size of Massachusetts and Rhode Island combined.

From surface to bedrock the soil of practically all interior Alaska is perpetually frozen. In prospecting shafts frozen ground has been reported to a depth of over 300 feet. In this frozen muck are found the remains of many prehistoric animals. The bones and tusks of the mammoth are the most numerous. In fact, it seems that few extinct animals have left such abundant traces behind them. One wonders what killed off these great beasts and how their bones became buried deep in the perpetually frozen muck. Their enormous size may be judged by a tusk unearthed near Fairbanks in 1932. This specimen measured 12 feet and 11 inches in length and weighed 295½ pounds.

As is true in all regions where mining is the main industry, the population of the interior country has shifted about as one field became exhausted and another discovered. Gold was first found on Mastadon Creek in 1893 and an army of prospectors soon gathered in the country around Circle City. At its height Circle is said to have contained 10,000 inhabitants. When the richer gold fields of the Klondike were discovered in 1896 the population shifted to Dawson which soon became the leading metropolis of the interior and contained 30,000 people. The Klondike field reached its peak in 1900 when $22,000,000 in gold was produced. But as the richer claims were taken up the population shifted to the Seward Peninsula where gold was discovered on the beach at Nome. As activities at Nome began to decline, a great number of prospectors explored the interior country and the rich fields north of Fairbanks were discovered in 1902. Gold production increased rapidly until the peak was reached in 1909 when the output for the year was valued at over $9,500,000. From 1902 to 1931 the Fairbanks district alone produced $90,830,000 which sum is nearly 10 times the amount paid by the United States for the entire Territory. By 1920 the rich claims were so exhausted that the expensive hand labor was scarcely profitable and Fairbanks seemed doomed to the inevitable period of decay so characteristic of mining towns the world over. However dredges were installed and the gold production has steadily increased until in 1931 the output was $2,655,000. Geological surveys indicate that placer- and lode-gold deposits in this region will not become exhausted for 25 years, so Fairbanks will no doubt continue to be the metropolis of the interior for a quarter of a century.

METEOROLOGICAL HISTORY

In 1882 the Signal Service of the Army began a system of meteorological observations at old Fort Reliance near Dawson, Yukon Territory, and at old Fort Adams near Tanana. A volunteer observer also began observations at this time at Fort Egbert (Eagle). Observations were made by the Coast and Geodetic Survey expedition in 1899 at Camp Coloma on the Porcupine River in latitude 67°25′ N., also at Camp Davidson, Yukon Territory in 1890. Observations began at Circle in 1897 and at Fort Yukon in 1899. These represent the only records kept in this region prior to 1900 and even these are far from complete. Some, in fact, extend over a period of but a few months as was the case at Camp Coloma. The stations were equipped in most cases with self-registering maximum and minimum thermometers and rain gages. Three observations were made daily, 7 a. m., 2 p. m., and 9 p. m. The records kept by the Signal Corps operators at Eagle, Fort Yukon and Tanana are excellent. The observers at these lonely, isolated stations have given faithfully and conscientiously their time and energy to the work.

Observations began at the Experiment Station Farm, 4 miles west of Fairbanks, in September 1904 and, excepting for a few months of the early years, the records are complete. Fairbanks was made a first-order station in 1929 and the office moved into town with quarters in the Horseshoe Building on First and Cushman Streets. The thermometer shelter was located on the bank of the Chena River, the elevation of the thermometer being 11 feet above ground. On July 1, 1933, the office was moved to the present quarters on the fourth floor of the new Federal Building. The thermometer shelter was moved to the roof of the building at an elevation of 68 feet. This exposure proved very unsatisfactory. In cold weather there invariably occurs a remarkable temperature inversion aloft. A change in elevation of 100 feet always shows a decided rise in temperature. Experiments during the winter of 1932–33 often showed a difference of 10° to 17° between the temperature on the roof of the Federal Building and that recorded in the thermometer shelter on the river bank. Due to this unsatisfactory exposure the shelter was moved to its former location on December 1, 1933.

GENERAL CLIMATIC CONDITIONS

The interior country, located as it is between two great mountain systems, has a decidedly continental climate. Extremes in nearly all climatic elements occur such as are recorded in Utah, Nevada, and in eastern Oregon and Washington. The rugged Alaska Range furnishes complete protection from the continuous storms that sweep across the Gulf of Alaska while the Endicott Range on the north is effective in turning aside the steady winds that blow in from the ice floes of the Arctic Ocean. To the west are the Kokrine Hills and Kuskokwim Mountains, a low detached range extending north and south across the plateau country. They are usually effective in obstructing the tempering influence of the Bering Sea. Upon rather rare occasions storms move up the coast of Siberia to a point north of the Aleutian Islands before swinging eastward. These move up the Yukon Valley behind the protecting coast range and produce mild weather with rather heavy snowfall and furnish some relief from the intense cold of winter. The severe storms that move along the Pacific coast each winter have little effect upon the interior. A pressure gradiant of 1.25 inches over the distance of 300 miles between Fairbanks and Cordova seems to be necessary before coast storms are able to pass across the mountains. When this occurs the effect is a slight moderation of temperature, but little or no snow is produced.

The winters are extremely cold and usually very little snow falls. The wet season comes in June, July, and August and the rain falls mostly as light drizzles. Storms of the thunderstorm type sometimes move in from the southeast and the rainfall produced may be rather excessive, that is, excessive for this country.

The growing season ranges from an annual average of 105 days at Nenana to 50 days at Allakaket. This may appear too short for farming but owing to the fact that there is continuous daylight all during the growing season, this is sufficient for many crops. The precipitation of 7 to 16 inches seems far too light for agricultural purposes. However, half of the annual precipitation falls during the growing season. In addition to this the perpetually fro-

zen muck keeps the surface water from draining away and becoming lost. As a result there seldom is any lack of moisture in the soil. Such vegetables as potatoes, turnips, radishes, lettuce, cabbage, and greens are easily grown. Tomatoes and cucumbers are grown in hothouses. Beans and peas may be grown during some years. The season is not favorable for melons, sweet corn, okra, etc. Field crops include hay, barley, oats, and rye. It might be said that truck gardening is the only practical type of agriculture and even this would not be profitable were it not for the local markets at the mining camps. As long as interior Alaska is so isolated and remote from any centers of population and competition is so great it is very doubtful if agriculture will ever become a leading industry. For a market the truck farmer must depend entirely upon the shifting population of the mining camps.

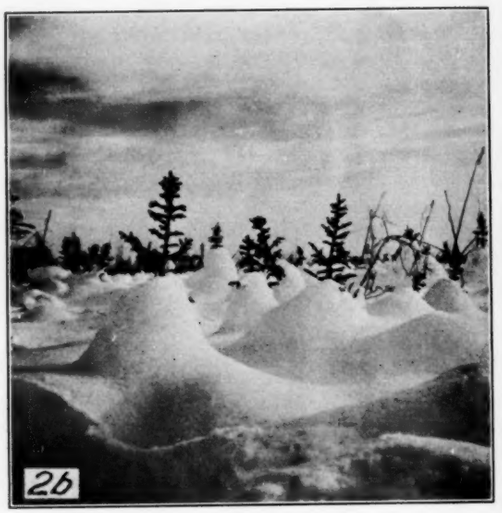
TEMPERATURE

From the past records at seven stations the mean annual temperature of the interior country is found to be 22° F. There are few inhabited regions of the world where such prolonged periods of extreme cold are recorded. From old settlers one often hears stories of isolated camps where the thermometer falls below −80° and remains below −70° for days. However much one may doubt the accuracy of such statements, this extreme cold is not at all impossible. The records from a network of cooperative stations at the various mining camps throughout the country would furnish very interesting statistics and might reveal some unusually cold locality similar to the famous region at Verkhoyansk, Siberia. Old inhabitants are of the opinion that the settlement of Birches, below Tanana on the Yukon River, is the coldest place in Alaska. Whether this is due to extremely low temperatures or to a combination of cold weather and high winds remains to be determined. The lowest temperature accepted as official for any Alaskan station is −76° at Tanana in January 1886. While the lowest for the entire region is −80° recorded at old Fort Reliance near Dawson, Yukon Territory.

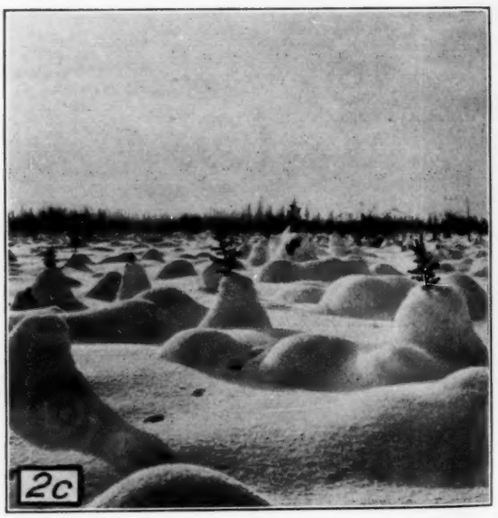
It is common knowledge the world over that temperature decreases with altitude, but the early settlers in interior Alaska must have been considerably surprised to find just the opposite condition here. Elevated points are always decidedly the warmer in winter. Gardens on the hillsides may have a month longer growing season than those in the valleys. The aviators were quick to take advantage of this condition and planes often take off in temperatures of −50° or lower, then climb to about 4,500 feet where the thermometer may record only 10° or 15° below zero. No definite information was known regarding this unusual condition until aero-meteorograph flights were inaugurated as part of the Polar Year program in 1932. The plane regularly ascended to altitudes of 17,000 feet or over and on frequent occasions the temperature aloft at no point was as low as that which prevailed on the ground. Slight temperature inversions were first recorded in October. As the cold weather of winter became more severe the temperature inversions became more pronounced and continued until the latter part of March. Only at rare intervals were they recorded during the summer months. The most striking example was recorded on the evening flight of December 28 when the surface temperature was −41° and a temperature of 1 above zero was recorded at an elevation of 4,000 feet. At times when surface temperatures were around 40° below zero it was somewhat amusing to hear the pilot complain of the heat aloft. The heavy fur parka and mukluks worn on the ground were uncomfortably warm in the higher temperatures aloft. The shutters on the motor cowling were not adjustable from the cockpit and when the motor was cowled down for cold weather flying it would at times become overheated in the warm air aloft and prevent the plane from attaining its maximum altitude.

Extremely cold weather is practically an annual occurrence. Almost every winter the thermometer falls to −60° or lower and occasionally zero or lower is recorded every day in a month, and again there are times when the thermometer never rises above zero during an entire month. At Fairbanks there is an average of 120 days each year with zero temperatures, and freezing weather occurs on 234 days in the year. The coldest year on record in the interior was 1909 with a mean annual temperature of 18.7°. The ice in the streams usually freezes to a thickness of 3 or 4 feet, depending a great deal upon the amount of snow that falls early in the season. The greatest thickness recorded on the Chena River at Fairbanks is 56½ inches in March 1933. In small pools about the gold dredges ice sometimes measures 9 feet or more. Frosts have been known to occur every month of the year but ordinarily the first frost of fall comes late in August. At this time there usually occur a few freezing nights then follow 2 or 3 weeks of delightful Indian Summer weather. The mosquitoes are gone, the summer rains are over and the wild berries are to be found everywhere. This period is without doubt the pleasantest time of the entire year. Freezing temperatures and snow flurries are common after the middle of September. The first zero temperatures occur by the second week in October and the rivers are soon frozen over. With the closing of the streams, winter begins. Temperatures of −30° are common in November, and in December the thermometer frequently falls to −50° or lower. January is the coldest month with temperatures of −60° or lower recorded at some point in the interior each winter. In February the extreme cold begins to moderate, however temperatures of −50° and −60° are sometimes recorded. By March the severe cold is over and the thermometer seldom falls below −40°. Subzero weather occurs early in April but by the latter part of the month the signs of spring are numerous. Freezing temperatures are common in May but the lengthening hours of sunlight melt the winter snow and the surface layer of soil begins thawing. The streams rise and the ice in the rivers breaks up early in the month. The average date of the opening of the Yukon River at Fort Yukon is May 10. On the Tanana River at Nenana the average opening date is May 7. The Porcupine River does not open until the last few days of May.

In 1913 Hudson Stuck, leader of the first successful ascent of Mount McKinley, left a self-registering thermometer at an elevation of 15,000 feet on the mountain. Nineteen years later the thermometer was found. The minimum temperature reading will never be known as the thermometer was graduated to −95° and the indicator in the tube had been forced back into the bulb, apparently indicating a temperature of more than 100° below zero. However, a temperature even of −95° is lower than any natural temperature ever before recorded on the earth's surface. There seems to be some doubt among certain authorities as to whether or not the thermometer was exposed properly. One member of the expedition was interviewed at the Fairbanks office and both still and motion pictures were exhibited of the thermometer when it was found. There seems no reason to doubt the accuracy of the incident. It was



Rime caps.



Snow cocks.

stated that the thermometer was resting in a slightly inclined position with the bulb end uppermost. By using the temperature of −95° and the maximum temperature of 100° recorded at Fort Yukon we have an absolute range of 195° for interior Alaska. However, the unusually low temperature occurred high on the slopes of the mountain and entirely out of the inhabited portion of the country. The absolute range for the inhabited region is 180° and the absolute range for any one station is 178° at Fort Yukon.

Rapid changes in temperature sometimes occur, one of the most remarkable of which was recorded at Fairbanks in January 1934. On the 6th the maximum temperature was 34° and on the 14th it had dropped to a minimum of −66°, making a range of 100° in 8 days. Later in the month a change of 72° was recorded in 2 days. To the people of the far North the extremely low temperatures are not as objectionable as might be imagined. To the residents of Dixieland a plain account of the cold no doubt may sound dreadful. The difference lies in the manner in which one is prepared for winter weather. With warm clothing and well-insulated houses a temperature of −40° produces scarcely any inconvenience whatever. The fact that the thermometer falls to 60° below, or lower, means very little to the daily life of the people. The extreme cold causes no more inconvenience than zero temperatures in the South. The mere cold alone can easily be endured, but when it is combined with even the slightest breeze it becomes almost unendurable. Another disagreeable feature always associated with extreme cold is the winter fog. At Fairbanks dense fog always accompanies temperatures of −45° or lower. The records for January 1934 show 348 hours with temperature −45° or lower and during this time there were 320 hours of dense fog. On one occasion the dense fog prevailed for 155 consecutive hours. During the coldest period there were three successive days with mean temperature −60°. It is very interesting to observe the formations of hoarfrost in cold weather. At −50° brick and stone chimneys leading from heated stoves always develop crowns of hoarfrost 6 or 8 inches high which resemble very much the formations around geysers and hot springs. A similar crown of frost forms on the ventilator outlets of heated buildings. The telephone wires, trees, fences, and all exposed objects become festooned with hoarfrost and produce very picturesque landscapes. Mounds of frost are built up around the base of all shrubs and small trees and if the extreme cold continues for a few weeks the plants may become entirely covered. A weird sight it is to look out across the level snow-covered country and see thousands of these frost mounds 2 feet or more in height dotting the landscape. Truly interior Alaska in midwinter is a photographer's paradise.

Although the winters are very cold, the summers are at times uncomfortably hot. Accounts of the early explorers on the Yukon River no doubt greatly astonished their readers. Lieutenant Schwatka, leader of an expedition in 1878, wrote as follows:

> The 29th of July was a hot, sweltering day with the sun and its thousand reflections sending their blistering heat into our faces. In fact, our greatest inconvenience, near the short Arctic strip of the stream, was the tropical heat * * *. We drifted down the hot river by low banks that needed nothing but a few breech-clouted negroes to convince us that we were on the Congo.

Dr. W. H. Dall, leader of another expedition, wrote in 1870:

> At Fort Yukon I have seen the thermometer at noon, not in the direct rays of the sun, stand at 112°, and I was informed by the commander of the post that several spirit thermometers, graduated up to 120°, had burst under the scorching sun of the Arctic midsummer.

And again:

> In midsummer on the upper Yukon the only relief from the intense heat, under which the vegetation attains an almost tropical luxuriance, is the brief space during which the sun hovers over the northern horizon, and the voyageur in his canoe blesses the transient coolness of the midnight air.

The account of Dr. Dall is somewhat misleading. It is very improbable, though not impossible, that a temperature of 112° was ever recorded by a properly exposed thermometer anywhere in Alaska. Most certainly no properly exposed thermometer has ever gone to 120°. It is not at all uncommon to see thermometers in the sun standing at 110° or over. The highest temperature recorded by a properly exposed thermometer is 100° at Fort Yukon. The maxima at other stations are: Fairbanks, 99°; Tanana, 91°; Rampart, 97°; Circle, 96°; Eagle 93°. Anyone who spends a summer in interior Alaska or Yukon Territory will most certainly be convinced that some days are unbearably hot and sultry. As a rule the long days of summer are cloudy and cool, but brief hot spells do occur in late June, July, and early August. Days with maximum temperature of 80° or over are very sultry and oppressing, producing a feeling of discomfort equal to a temperature of 100° in the midwestern States. In addition to the discomfort caused by the heat, one must endure the hoards of vicious mosquitoes and the troublesome gnats. Some idea of the Arctic mosquitoes may be gained from the following account of C. F. Hall:

> Among the numerous visitors that greeted us on our arrival, I was astonished to find myriads of musquitoes. Little did we expect so warm a reception in the Arctic regions. Talk about musquitoes in the "States" as being numerous and troublesome! Why, no man who has not visited the Arctic shores in the months of July and August can have a good idea of these liliputian elephants. In the "States" the very hum of a musquito is enough to set any one upon his guard. How many a poor soul there has been kept in a state of torment all night by the presence of only two or three musquitoes! But here, in the North, it is a common, every-hour affair to have thousands at one time around you, some buzzing, some drawing the very life blood from face, hands, arms, and legs, until one is driven to a state approaching madness. Even the clothing worn in the "States" is no protection here against the huge probosis with which each lady musquito is armed.

It can truthfully be stated that the mosquitoes are just as numerous now as they were 74 years ago when Hall first journeyed to the Arctic regions.

COLD WAVES

The term "cold wave" as applied to regions in the "States" has little meaning in the interior of Alaska unless one thinks of a cold wave as lasting 2 or 3 months. There are times when minimum temperatures of zero or lower are recorded each day for a period of 1 or 2 months. There are occasions when the maximum temperature remains below zero for an entire month. In the Northern States a cold wave means a drop in temperature of 20° in a 24-hour period, to a minimum of zero or lower between December 1 and March 15, and to a minimum of 16° between March 16 and November 30. Cold waves are not as frequent in this country as might be supposed, for when winter begins the temperature falls and remains fairly constant over long periods of time. At times, however, high-pressure areas move in from Siberia and send the temperature from its already low point down to a figure far below the limit of mercurial thermometers. The first cold wave in the fall is important, as it marks

the ending of the season's work on the gold dredges. As mining is the main industry, most activity ceases and the laborers spend the winter in town or go "outside". It is interesting to follow these cold waves southeast across Canada and on until the Atlantic States are reached about 2 weeks later. The cold wave that set a new record of −66° at Fairbanks in January 1934 was felt in Massachusetts 15 days later. After being in operation more than 20 years the station at Fort Yukon was closed and official records ended on January 12, 1934, with a minimum temperature for the day of −64°. Had the station been in operation 2 days later, a new low temperature record would have been established for Alaska. At 9 a. m. on the 14th the temperature given in an Airways report was −75°, and later in the day the thermometer was observed at −78°. This is 2° lower than the official record established at Tanana in 1886. In February 1932 a privately owned thermometer at Alatna, near Allakaket, registered −82°, but this thermometer was destroyed by fire before it could be secured for testing at low temperatures. During 19 years of concurrent records at Allakaket and Tanana the minimum temperatures for January and February were invariably lower at Allakaket, the average being 9.4° for January and 11.7° for February. During this period −70°, the lowest, was registered three times at Allakaket; the corresponding minima at Tanana were −68°, −62°, and −68°. There can be little doubt that temperatures lower than −76° have occurred at both Fort Yukon and Allakaket since the record was established at Tanana. The most severe cold period on record at Fairbanks was that of January 1934, when the temperature averaged −51.0° for 2 weeks. The minimum was −66° and there were 2 days when the maximum was −56°. However, this cold period falls far short of the one that occurred in December 1917 at Dawson, when the temperature averaged −51.3° for the month. To better comprehend this extreme cold one has but to compare it with other regions of the world. The lowest temperature encountered by Peary on his dash to the North Pole was −53°. As yet the lowest temperature recorded in the Antarctic is −73.3°, reported by Amundsen at Framheim in 1911. Some members of the Scott Expedition were said to have encountered a temperature of −77° near Cape Crozier in 1911.

The following table is a record of the minimum temperature and the lowest monthly mean recorded by various polar expeditions as well as for a few inhabited regions of the world that are noted for extremely cold winters. It is interesting to compare these with similar records for the Alaska-Yukon country.

	Minimum	Lowest monthly mean		Minimum	Lowest monthly mean
	°F.	°F.		°F.	°F.
First Byrd Antarctic Expedition	−72	−44.7	Tibet	−40	[1] 9.0
Amundsen Antarctic Expedition	−73	−48.1	Leh, Kashmir (11,500 feet)	−19	[1] 17.3
Belgica Antarctic Expedition	−46	−10.3	Misti, Andes Plateau, altitude, 19,200 feet		[1] 21.4
Cape Adare Antarctica	−43	−13.4	Mount Washington, N.H., 1933	−46	5.0
McMurdo Sound Antarctica	−60	−21.5	Fort Reliance (Dawson)	−80	−51.3
2nd Grinnell Expedition, latitude 78°37′N	−69	−38.1	Fort Yukon	−78	[2] −48.4
Peary Expedition to North Pole	−53	−31.7	Tanana	−76	−36.7
Verkhoyansk, Siberia	−92	[1] −59.0	Eagle	−75	−45.8
			Allakaket	−70	−44.8
			Fairbanks	−66	−36.6
			Mount McKinley	[3] −100	

[1] Lowest monthly normal.
[2] The lowest monthly mean −48.4° at Fort Yukon is much too high as −39° was used as the maximum temperature on 26 days when mercury was frozen. This occurred in December 1917.
[3] Absolute minimum unknown.

PRECIPITATION

Located within an area protected by mountains the interior country is semiarid. However, the term semiarid is somewhat misleading. For 6 months of the year the ground lies frozen beneath a mantle of snow. In summer the deep layer of moss and decayed vegetable matter acts as a mulch which effectively holds the moisture in the 2-foot layer of thawed ground. The precipitation is light. In the northern section Fort Yukon has an annual average of only 7.28 inches. To the westward the precipitation steadily increases as the distance to the Bering Sea decreases. With the exception of the slopes of the Alaska Range the greatest precipitation is recorded at Hot Springs, the annual average there being 16.15 inches. The variation in the greatest precipitation recorded in 24 hours is considerable, ranging from 4.0 inches at Tanana down to 0.07 inch at old Fort Reliance. This shows that the maximum rainfall in a day, like the mean annual precipitation, is greatest in the western section nearest the Bering coast. The period of heaviest rainfall occurs in June, July, and August, while the least is recorded in February, March, and April. At Fairbanks there is an average of 92 days annually with 0.01 or more precipitation. As is indicated, the rains are light, rarely measuring as much as 0.25 inch in a day. Due to the thick covering of moss over the frozen ground, the soil is cool and damp. Evaporation takes place slowly and the humidity of the air is greater than in most semiarid regions. The water vapor is carried aloft and upon cooling is formed into cumulus clouds that produce occasional thunderstorms. At times there are heavy showers of short duration followed by clearing skies, but most of the rain falls as steady light drizzles that may continue for several days. The greatest precipitation for any one month on record is 8.19 inches, in August 1930, at the experiment station near Fairbanks. At rare intervals the thunderstorms are accompanied by hail. The hailstones are about the size of buckshot; and as the storms last but a few minutes, there is little or no damage done. An exception, however, occurred at Allakaket in July 1921 when a hailstorm was severe enough to damage the garden crops. At Fairbanks hail has been recorded but 10 times during the past 5 years.

SNOWFALL

Upon rare occasions the first snow of Autumn may fall in August and by the middle of September snow flurries are quite common. However, it is not until the middle of October that any appreciable amount of snow falls and remains on the ground. The heaviest snows occur in January, while October and March receive the least during the cold winter. Even during the midsummer month of July snow is sometimes reported at Wiseman. From the latter part of October to the middle of March there are very few occasions when the temperature rises above 32°, and as a result the snow accumulates on the ground to a depth of 3 feet or more. This often gives an erroneous impression regarding the total snowfall for the season. The average snowfall in the interior is about 50 inches. Very little difference can be noted between the different sections on the Yukon and Tanana Rivers, as both the greatest and the least mean annual amounts were recorded in the eastern section. The greatest annual snowfall of which records are available is 110 inches at Allakaket in 1921, while the least is 13.9 inches at Rampart. The snow is seldom deep enough to interfere with traffic and there are times when it is so light as

to impede sled travel. Due to the extreme cold, the snow is light and dry. Only rarely does it fall in large feathery flakes so commonly seen in temperate regions. Over most of the country the wind in winter is light and variable, with long periods of calm. As a result the snow remains fairly evenly distributed over the ground. At Fairbanks there is an average of 184 days each year with 1 inch or more of snow on the ground. The snowfall of the winter of 1928–29 is no doubt the most notable of recent years. At Fairbanks the total snow for the season amounted to 94.7 inches. There was little or no property loss, but considerable inconvenience was experienced in keeping the streets cleared and in obtaining fuel. The heaviest 24-hour snowfall on record at Fairbanks is 13.0 inches. One peculiarity of the climate is the extended periods of light snowfall. There are occasions when the fine, dry snow falls continuously for several days yet the accumulated depth may amount to scarcely more than a trace. At times the snowflakes are so small as to be practically invisible unless observed against a dark background. In regions outside of Alaska one sometimes hears the expression, "It is too cold to snow." It would be of interest to know the lowest temperature at which snow has ever been reported. In interior Alaska snow often occurs at temperatures far below zero. During a mild storm on January 16, 1934, Jarvis reported snow at −38°, McCarty at −40°, Richardson at −49°, and at Circle, heavy mistlike snow was reported at a temperature of −52°. Due to the almost total lack of wind during the cold weather, blizzards are virtually unknown over most of the interior country.

FLOODS

Floods occur almost annually on the larger streams and at intervals of several years they assume destructive proportions. The floods are local and are caused by ice jams following the spring breakup. A mild winter with heavy snow is sometimes followed by a cold spring, and water in the rivers remains low and frozen tight. Then with an abrupt change the days become warm and the streams rise, causing the ice to break up quickly. When this occurs the ice is piled up in tremendous jams at the narrow points of the streams and floods follow. In 1930 the Chena River at Fairbanks rose 12½ feet above the normal water level. Practically the entire town was flooded and it is said that water was 2 feet deep in the business district. Considerable property loss occurred. The Yukon River is sometimes dammed by immense ice jams near Fort Yukon, and when this occurs the stream rises and spreads out over the Yukon Flats until it is 15 to 20 miles wide. At Circle City the stream has been known to rise 25 or 30 feet and flood the entire city until water stood 6 feet deep in the post office. Summer floods sometimes occur on the Tanana River and other streams originating in the Alaska Range. These floods are caused by the rapid melting of the glaciers during the unusually hot weather. Owing to the sparsity of population, about one person for each 15 square miles of land, the damage due to floods is comparatively light. With but one highway and one railway in the country there are but few bridges to be washed out, almost no livestock to be drowned, and few indeed are the towns to be destroyed.

CLOUDS

Almost without exception the semiarid plateau regions of any country are noted for their cloudless skies. How different is the interior section of Alaska, for here prolonged cloudiness is the rule. At Fairbanks there is an average of 88 clear, 89 partly cloudy, and 188 cloudy days each year. The mean daily cloudiness as determined from 4 years of records is 6.4. The period of greatest cloudiness falls during the summer months, the mean for August being 8.0. During the brief intervals of daylight in winter the sky is usually obscured by ground fog or stratus clouds. As the season of extreme cold ends, the cloudiness decreases and clear skies generally prevail from the latter part of February to early in April. Then when the warm days of spring approach there is a decided increase in daily cloudiness. During the continuous daylight of summer clear days are the exception, but as summer ends and the cool days of the short autumn season begin the cloudiness decreases. The period of clear skies in autumn is very brief, for as cold weather begins, in October and November, the cloudiness increases and continues until the cold days of winter are over. Stratus and alto-stratus clouds predominate in winter. Cirro-stratus clouds are commonly seen and occasionally alto-cumulus are recorded. Strato-cumulus begin to appear in March. About the second week in April the cumulus clouds are first seen. As they are the first signs of spring, they are a welcome sight and are a relief from the dull stratus clouds that prevail during the long cold winter. During the warm summer days moisture evaporating from the wet spongy moss rises and forms picturesque cumulus clouds, the beauty and grandeur of which are almost without equal in other lands. One characteristic of the inland country is the rainless thunderstorms. On almost any clear, calm morning in July a few small cumulus clouds may be seen on the southeastern horizon. These increase and by midafternoon the sky is filled with turbulent thunderheads which roll and tumble about above. They are very dark and threatening and a downpour seems imminent. Perhaps a little rain will fall, but usually as evening approaches the clouds begin dissipating. The phenomenon has all the characteristics of a typical thunderstorm, but there is seldom any thunder to be heard. At Fairbanks thunder is recorded on an average of seven times annually. The sound is usually weak and far distant. The terrific crashes so common in the thunderstorms of the Midwest are seldom if ever heard in interior Alaska. True cirrus and cirro cumulus clouds are sometimes observed in the spring and fall, but only at rare intervals.

HUMIDITY

It is difficult to think of interior Alaska as being a semiarid country. The scanty precipitation is the only feature that is characteristic of such regions. Due to the perpetually frozen subsoil and the surface layer of moss and decayed vegetable matter, the soil seldom becomes parched and dry as is true elsewhere. The mean annual relative humidity at Fairbanks is 71 percent, which is rather high for a semiarid country. The percentage of relative humidity by months is as follows:

January	81	July	66
February	76	August	74
March	66	September	73
April	61	October	72
May	58	November	81
June	62	December	83

As can be seen, the period of highest humidity occurs during November, December, and January. Records fail entirely to uphold the proverbial arguments that due to the dry cold of the interior the winters are more comfortable than the damp foggy cold weather on the coast. At Fairbanks in January 1934 the mean temperature was −31.2°, the mean relative humidity 87 percent and

there were 320 hours of dense fog. However it cannot be denied that there is very little moisture in the air during the extremely cold weather. The argument concerns the difference between absolute and relative humidity. A temperature of 37° and relative humidity of 1 percent would most certainly be considered dry air; but if the temperature of this same air is lowered to −44°, the relative humidity becomes 100 percent and dense fog prevails. The question then seems to be is the air at −44° as dry as it was at 37°? During the numerous foggy days with temperature ranging from −45° to −60° the percent of relative humidity in the outdoor air is very high. However, in business houses and offices where the air indoors is heated to 70° and very little moisture is added, the relative humidity is greatly reduced, often remaining at 10 percent or lower for days at a time. There is often a very great difference between the temperature of the indoor and outdoor air. On the morning of January 14, 1934, the temperature in the office at Fairbanks was 75°, while at the same time the thermometer outdoors stood at −65° making a difference of 140°. The air indoors is so dry that everything becomes parched and so charged with electricity that one is continually receiving electric shocks whenever metal or other conductors of electricity are touched. The peculiar antics of this static electricity are sometimes quite amusing. At times when two persons touch hands they each receive a light shock and a crackling sound is produced as the sparks jump from one to the other. When several carbon copies of a report are being typewritten the onion-skin paper becomes charged in such a way that the pages attract and adhere to each other as if they were lightly glued together. The sheets of carbon paper are charged in the opposite manner and at times they repel each other to such an extent that when removed from the typewriter they will not remain in a drawer unless it is closed. In dwellings where vapor from the kitchens increases the relative humidity of the indoor air, static electricity is not noticed.

SUNSHINE

The only automatic sunshine recorder in the country is located at Fairbanks and the records here cover a period of only 3 years. These records show the average number of days each year without sunshine to be 83. The average number of days with 100 percent sunshine is 58. In December 1933 there were 21 days with zero percent and in March 1931 there were 17 days with 100 percent sunshine. During the long days of summer, perpetual daylight prevails over all the country and in the northern section the sun is above the horizon continuously. As there is no darkness at Fairbanks during the Fourth of July celebrations, a midnight ball game is sometimes substituted for the customary display of fireworks. In winter the conditions are just the reverse. In the northern section there is no sunlight whatever for a period of 3 weeks. At Fairbanks the sun reaches an altitude of 1° 42′ and remains above the horizon for 3.7 hours on the shortest days. Except for a few days at the time of the summer and winter solstices the change of possible sunlight averages 6 minutes per day. The percentage of possible sunshine by months as recorded at Fairbanks is as follows:

	Percent		Percent
January	29	August	32
February	51	September	28
March	70	October	33
April	67	November	33
May	52	December	38
June	61	Annual mean	45.3
July	50		

Solar-radiation records have been kept at Fairbanks for the past 3 years. Due to the high latitude of the station, the continuous records are of great interest. During the cloudy weather of December there have been days when no radiation whatever was received during the 3.7 hours the sun was above the horizon. The mean daily amount of radiation in gr-cal. per square centimeter for December is only 5.3. In June, with a maximum of 21.9 hours of sunlight, the mean is 476.7. The greatest amount received in any one day was 714.2 on June 22, 1933.

WINDS

Fairbanks is the only station at which complete wind records are kept, but it is believed that conditions are very much the same over most of the interior country. Perhaps the most striking peculiarity of the climate is the total lack of wind for long periods during the winter months. January, the month with the least wind movement, has an average of 323 hours of calm. The greatest number of consecutive hours of calm is 51, in 1934. In January 1934 there occurred a period of 82 hours during which but 1 mile of wind was recorded. The hours of calm in January 1933 numbered 399, which is 54 percent of the total hours in the month. The highest wind movement occurs in May, when the mean monthly velocity is 5.7 miles per hour. The highest velocity ever recorded at Fairbanks since the automatic recorder was installed was 32 miles per hour on May 12, 1934. So accustomed have the inhabitants become to the quiet air that velocities of 18 miles per hour or over are very disagreeable. There is an average of 11 days each year with maximum velocities of 20 miles per hour or over, but even these moderate winds are of short duration. The 3 years of records at Fairbanks show a total of 4 days when no wind movement was recorded. Only three times has the daily total movement exceeded 300 miles, the highest on record being 367 miles. The total monthly movement ranges from a minimum of 1,020 miles in December 1931 to a maximum of 5,311 in May 1934. During the winter the light winds are quite variable, there being times when scarcely 2 consecutive hours during a day have the same direction recorded. However the prevailing direction in winter is from the northwest and in summer from the southwest. The highest velocities are usually from the northeast.

The section of country near the confluence of the Tanana and Yukon Rivers is quite exceptional. In this region the river valleys furnish a drainage system for the air from the interior plateau. About 75 miles above Tanana the Yukon River enters a narrow gorgelike valley through which it flows in a series of deep rapids. In winter a high-pressure area usually prevails over interior Alaska while to the southwest is the rather permanent Aleutian low. This pressure distribution is favorable for easterly winds over the interior. In most sections these winds are not encountered to any extent on the surface but down the two river valleys, from Rampart and Hot Springs westward, the easterly gales rage at subzero temperatures frequently throughout the winter. In summer the general pressure distribution is reversed and the westerly winds prevail. No wind records are made in this region but the temperature records show a minimum of −76° at Tanana and −68° at Rampart. Other regions of high winds are reported in the vicinity of Bettles, where the Koyukuk River flows down from the Endicott Mountains, and on the Chandalar River which flows down from the mountains farther to the eastward. Stories are told of high winds encountered on the sled trails with the thermometer

standing at 58° below zero. Truly these regions must closely rival "The Home of the Blizzard" which the Mawson Expedition encountered in the Antarctic. The gales sweep the snow from the rivers and leave the ice polished and smooth as glass. Travel by dogsled is very difficult, for at times the dogs, sled, and driver are blown across the smooth ice and piled up in the brush along the shore. High winds are also often encountered at high elevations such as Eagle Summit, the divide between the Tanana and Yukon watersheds on the trail from Fairbanks to Circle City. With these exceptions the interior of Alaska is noted as a region of very light winds. The mean annual velocity at Fairbanks is 3.8 miles per hour.

PILOT-BALLOON OBSERVATIONS

Pilot-balloon observations began at Fairbanks, August 26, 1930. Due to the unusually clear air and relatively light winds aloft, the balloons are sometimes followed to very high altitudes. On March 14, 1931, an observation lasted 122 minutes and if the ascension rate remained constant the balloon was lost at an altitude of 72,600 feet. The records for this unusual observation appear very good for 108 minutes but beyond that point they may be somewhat questionable. The altitude at 108 minutes was 19,530 meters and the horizontal distance 44,800 meters. On May 23, 1933, a balloon was abandoned at a distance of 60,600 meters after being followed for 100 minutes. This is the greatest distance to which a balloon has been followed. The varying conditions under which these observations are made adds interest and variety to the work. In winter the prevailing ground fogs hinder the work a great deal, but observations are frequently made at temperatures below −40°. The coldest run was made at 52° below zero. The winds aloft are usually moderate to fresh and only rarely are velocities of 40 miles per hour or over recorded. It is interesting to note the winds aloft that sometimes prevail during periods of high and low barometric pressure. During an observation on October 12, 1933, the barometer stood at 29.02 (reduced to sea level) and the highest velocity recorded was 4 miles per hour. The balloon entered alto-stratus clouds at 9,200 feet, being only 1,100 feet away horizontally. Eight days later the barometer stood at 30.92 and the balloon observation revealed winds of hurricane force aloft. The velocity at an elevation of 24,000 feet was 78 miles per hour.

RADIO METEOROGRAPH OBSERVATIONS

An interesting part of the Second International Polar Year program was the radio-sounding-balloon work. Regular sounding-balloons were released carrying aloft small radio transmitters which automatically sent out temperature and pressure data. The signals were picked up on a short wave receiver in the office. The balloons were also observed through the theodolite and the winds aloft plotted in the usual manner. The balloons were given an ascension rate of 200 meters per minute and under favorable conditions complete records were obtained until the balloons burst. The maximum altitude reached was 18,355 meters and the greatest distance to which the balloons were followed was 62,700 meters. One balloon was followed to a distance of 83,500 meters, but the records for the last few minutes of the observation are somewhat questionable. It is rather surprising to note that in practically every instance the long pilot- and sounding-balloon observations revealed easterly winds high up in the stratosphere. During the spring and summer that radio sounding-balloon observations were made, the mean altitude of the stratosphere was found to be 11,800 meters.

CHINOOKS

A few occasions occur each year when the pressure gradient between the interior and the coast becomes so great that mild storms pass over the mountains and cause a chinook condition to prevail. During these periods, winds of strong to gale force prevail aloft and a few foehn clouds may be observed. Although temperatures may rise 20° or more, the thawing usually associated with chinook winds does not occur, for seldom does the thermometer rise above the freezing point during winter. In January 1934, a storm moved in across the mountains and resulted in what might be termed "chinook conditions." The temperature at Fairbanks rose rapidly to −35°, but when the storm moved away the temperature dropped to −60° for the second time during the month. The warm chinook winds of the Midwestern States are almost unknown in the plateau section of Alaska.

BAROMETRIC CHANGES

A somewhat surprising characteristic of the climate is the little effect produced by extremes of barometric pressure. The violent storms usually associated with unusually low barometer readings are unknown. In fact, interior Alaska is a region where violent storms are virtually unknown. Periods of low pressure are often accompanied by mild weather with little or no wind, while the opposite effect is sometimes noticed during periods of unusually high pressure. During the past 3 years the barometric pressure at Fairbanks has been below 29.00 inches on seven occasions, the lowest being 28.73 inches. Two times in 1933 the pressure was above 31.00 inches. On March 1, 1934, a pressure of 28.73 inches (sea level) was recorded. On the 6th the barometer had risen to 30.76 inches, making a range of 2.03 inches in 5 days.

HALOS

During the cold days of winter the sun shining through cirro-stratus clouds often produces very interesting halos. The ordinary halo of 22° is frequently observed. The great halo of 46° is noted several times each year and upon rare occasions there occurs a combination of halos, arcs, and parhelia that is truly marvelous. Such a display occurred on April 7, 1933. On this occasion there was a very brilliant circumzenithal arc, a great halo of 46°, a parhelic circle, two parhelia of 22°, and a paranthelia of 120°. The display was repeated on the following day, although not on so grand a scale. This display included the brilliant circumzenithal arc tangent to a great halo of 46°. The parhelic circle and paranthelia of 120° were not observed, but a halo of 22° with a tangent arc on the upper surface was present inside the great halo of 46°, as well as two brilliant parhelia of 22°. On June 23, 1934, a very peculiar halo was observed. The upper and lower surfaces were 22.2° from the sun, while the right and left surfaces were at a distance of 32.7°. In addition, there appeared a quarter arc on the lower right-hand surface at a distance of 39.7°. Then upon the lower surface was a tangent arc parallel to the horizon. Parhelia are observed more frequently even than the halo of 22°, and at times they are exceedingly bright. On January 16, 1934, right and left parhelia were observed, together with a light pillar and the rare vertical parhelia. All were exceedingly brilliant and remained visible for

about an hour. On several occasions paraselenae have been observed, and on clear, cold nights a full moon shining through a few thin alto-cumulus clouds sometimes produces coronas that are wonderful to observe. In this connection might be mentioned the colored alto-cumulus and alto-stratus clouds that are sometimes observed when no parhelia or halo is present. Usually these are small detached clouds about 15° to 20° from the sun. They may include all the colors of the rainbow and resemble delicate mother-of-pearl.

AURORAS

As might be expected in this latitude, auroral displays are frequent. There is an average of 176 days annually on which they are recorded. There seems to be a popular belief that the aurora is generally associated with cold weather. Records at Fairbanks show little connection between this phenomenon and prevailing weather conditions. No auroras are observed during the summer season, simply because they are not visible during the continuous daylight. By the end of July there is a short period of deep twilight at midnight, and the brightest stars are once more visible. The darkness rapidly increases, and 2 weeks later the first aurora may be observed. The displays are frequent from this time until May, when continuous daylight again prevails. During the past 4 years the physics department of the Alaska Agricultural College near Fairbanks has been measuring the height of the aurora by means of simultaneous photographs at stations about 15 miles apart. The general height as determined from these measurements ranges between 60 and 200 miles.

EARTHQUAKES

No severe or destructive tremors have been recorded in the interior of Alaska. However, the number of light shocks averages eight annually. The center of disturbance seems to be to the southwest, near the "Valley of Ten Thousand Smokes." Many active volcanoes are located in this region. The eruption of Mount Katmai in 1912 was one of the most terrible known anywhere on the earth.

AVIATION

Commercial aviation is playing such a great part in the development of interior Alaska that this article would hardly be complete without a few remarks regarding this modern means of transportation. For about 15 years following the discovery of gold, the shallow-draft river boats furnished the only means of summer transportation. In winter all traveling was by dog sled and this condition still prevails over much of the country. In 1905 the Alaska Road Commission was organized and a road was constructed from Valdez, on the coast, to Circle City on the Yukon River, a distance of 500 miles. In addition to this trunk line a few miles of feeder roads, mostly in the Fairbanks district, have been constructed as the need arose. On the high passes the road is blocked by snow from October to the middle of June each year. When the Alaska Railroad was completed in 1923 the interior country became easily accessible the year round. The railroad extends from Seward, on the coast, to Fairbanks a distance of 470 miles. The weekly trains make connections with the steamboats and one may now travel from Seattle to Fairbanks in 8 days. Upon the completion of the railroad Fairbanks became the distributing center for central and western Alaska. Travel and transportation had greatly improved since the pioneer days at the beginning of the century. However the interior country is a vast region equal in size to the State of California. With but one road and one railway, the transportation system was about equal to that of the Middle West at the close of the Civil War. The introduction of commercial aviation has brought about wonderful changes during the last 10 years. The late Col.

Form No. 1131-Aer.

U. S. DEPARTMENT OF AGRICULTURE
WEATHER BUREAU

PILOT'S WEATHER REPORT

Date January 14, 1934. Time A.M. Issuing station Fairbanks, Alaska.

STATION	ELEVATION (FEET)	TIME (A. M. OR P. M.)	GENERAL CONDITION	CEILING (FEET)	VISIBILITY (MILES)	WIND DIRECTION AND VELOCITY	TEMPERATURE (DEG. F.)	DEW POINT (DEG. F.)	BAROMETER (SEA LEVEL)	REMARKS—FIELD CONDITION
Fairbanks		8a	dense fog	zero	zero	calm	-62		30.40	
Nenana		745a	clr	unl	unl	calm	-64		30.38	grnd.fog w
Hot Springs		730a	clr	unl	unl	calm	-70		30.02	patches grnd.fog
Tanana		745a	clr	unl	unl	calm	-62		29.95	
McGrath		8a	clr	unl	unl	e 1	-65		29.90	patches grnd.fog
Richardson		745a	clr lt fog	unl	poor	calm	-54			
McCarty		745a	dense fog	zero	zero	e 4	-51			
Jarvis		745a	dense fog	zero	zero	calm	-50			
Circle		730a	clr	unl	unl	calm	-70		29.62	
*Fort Yukon		745a	clr	unl	unl	calm	-75		30.32	lt.grnd.fog on river to S.
Eagle		845a	clr	unl	unl	calm	-49		29.20	

*Temperature on river at Fort Yukon reached -78° at 11 am.

Ben Eielson inaugurated air-mail service about 10 years ago, when experimental flights were made from Fairbanks to McGrath. The distance of 300 miles required 17 days by dog sled as compared to 2 hours and 45 minutes by plane. These flights demonstrated completely the practicability of air transportation and the citizens of Alaska are without doubt now more "air minded" than the people of most countries. Landing fields have been constructed at practically every mining settlement and throughout the year a day seldom passes without flights being made to some remote section of the country. The 5-hour flight to Nome is made several times each week. By dog sled, with the best of trail and weather conditions,

U. S. DEPARTMENT OF AGRICULTURE
WEATHER BUREAU

PILOT'S WEATHER REPORT

Date January 14, 1934...

Time A.M.

SPECIAL REMARKS

WINDS ALOFT, ALTITUDES IN FEET ABOVE SURFACE

STA. Fairbanks ELEV. 455		STA. Nome ELEV. 8 1		STA. ELEV.			
ALTITUDE (FEET)	DIR.-VEL. (MPH.)	ALTITUDE (FEET)	DIR.-VEL. (MPH.)	ALTITUDE (FEET)	D	DE	DIR.-VEL. (MPH.)
Foggy	None	Surf	wnw 4				
		1000	wnw 2				
		2000	nnw 2				
		3000	nne 8				
		4000	ne 24				
		5000	nne 28				
		6000	nne 28				
		7000	n 32				
		8000	n 34				
		8600	n 34				

this trip usually required 3 weeks. Planes go almost daily to the nearby settlements and at frequent intervals flights are made to Bethel, Kotzebue, Wiseman, Fort Yukon, Dawson, and other distant points. Occasional trips are made to Whitehorse and to Point Barrow. An idea of the important and varied services rendered by the aviation companies may be gained from the following incident. At 2 a. m. this radio message was received from Point Barrow, "Rush a plane to Cape Halkett Mrs. ——— and child seriously ill matter of life and death". At 4:45 a. m. a plane left Fairbanks, stopped at Wiseman 200 miles away for gasoline, and went on to Cape Halkett, located on the Arctic coast 100 miles east of Point Barrow. The mother and child were in the Point Barrow hospital at 11:10 a. m., the plane having covered a distance of over 600 miles in 6½ hours.

In general, aviation work is perhaps much the same the world over, but in many regions special conditions arise which the pilot must know how to meet. Trouble is very likely to follow if the seemingly insignificant details are ignored. The only hangars available in the interior of Alaska are those located at Fairbanks. When planes are forced to remain outdoors in cold weather they frequently become coated with frost in a very short time. This must be wiped off, as the frost so disturbs the airflow over the wings that their lifting power is lessened and a take-off is hazardous. In cold weather the oil must be drained from the motor immediately after landing. Before beginning a flight the motor is covered with a canvas hood and warmed with a gasoline torch. The oil must be heated, poured in, and the warmed motor started at once. In cold weather the preparations for a flight often require considerable time. Forced landings in the uninhabited country might prove quite serious; and as landing fields may be 100 miles or more apart, the planes must always be kept in perfect condition. The efficiency and safety of commercial aviation in interior Alaska may be judged from the fact that in 10 years there have been but two plane crashes in which passengers have been killed. Surely there are few countries with such a record. Forced landings are almost unknown, yet they must be taken into consideration and ever be guarded against. As emergency equipment the planes carry several days' rations, a rifle and camping equipment. This and the extra gasoline needed often greatly reduces the pay load of the planes. Experience soon shows the necessity of an extra supply of gasoline, which in some communities costs $2 per gallon. On a recent attempted flight to Point Barrow the pilot was forced to turn back on account of fog when but a few miles from his destination. The nearest landing field was at Wiseman, 300 miles back across the Endicott Mountains. Another plane flying from Fairbanks to Kotzebue was unable to land at the latter place and was forced to return 250 miles to the landing field at Ruby. As a rule flying activities cease when the temperature falls to 40° or 45° below zero, but this is not always the case. There are any number of flights made in temperatures of −50° and −60°. The coldest flight on record for Alaska and perhaps the coldest made anywhere in the world occurred at Eagle in January 1934, when a temperature of 71° below zero was recorded. For 6 months of the year all planes operate on skiis and landings can be made almost any where on the snow-covered ground. In summer both wheels and pontoons are used. The planes equipped with pontoons have no trouble in landing on the numerous streams, but those on wheels are limited entirely to the few widely scattered landing fields. River transportation is available only when the streams are open and sled travel is limited to the winter months when snow is on the ground. There occurs a period of several weeks each year when the streams are closing and again during the spring break-up, when the only means of transportation is that furnished by airplanes.

For a number of years there was no Airways Weather Service and pilots often made long flights with no knowledge whatever of prevailing weather conditions along the route. By 1929 air commerce had become so well established that the need of an adequate Airways Weather system was apparent. Fairbanks was made a first-order station and became the headquarters for airways work in the interior country. Observers were appointed at

places where radio communication was available and weather reports are now being received once or twice a day from about 30 stations. A number of settlements having landing fields and being frequently reached by plane are without radio communication. As a result an unusual condition prevails in that transportation is ahead of communication. Aviation is advancing rapidly and the Government has done much to aid this important means of transportation. Yet much remains to be done. There are no teletype lines bringing in their hourly weather sequences, no network of off-airway reports to enable the meteorologist to issue frequent trip forecasts, no lines of beacon lights to guide the pilots during the long winter nights, no radio beacons for the planes to follow in bad weather, no emergency landing fields at short intervals and no Department of Commerce radio stations to send out forecasts and warnings to pilots in the air.

CONCLUSION

To the early explorers drifting down the great Yukon River in summer, interior Alaska seemed a land of dismal swamps and jungles in which "the vegetation attains an almost tropical luxuriance." A land of sweltering heat forever condemned to the hordes of gnats and the mosquitoes "that measure 6 inches from wing to wing."

To the lonely prospector mushing over the bleak, barren hills ever in search for gold, Alaska was pictured as a land of "6 months night when 'twas 60 below with howling wind and pelting snow", a region to be tolerated only as long as "pay dirt" could be found.

To the permanent settlers who built their homes in the Far North, the country with its quaint pioneer life, its picturesque winter landscapes, its abundance of game, its profusion of berries and wild flowers soon became a region as dear to their hearts as the palm-fringed lagoons are to the South Sea islanders.

The meteorologist finds in the country with its great temperature extremes, its remarkable changes in weather, its halos and auroral displays, a region so full of interest that he cannot help but become enthusiastic in his work. Surely there are few regions in the world as interesting as the interior section of Alaska.

Monthly normal temperatures (°F.)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Fairbanks	−10.8	−0.1	10.2	28.5	47.3	58.5	60.3	55.5	43.5	26.4	3.1	−6.2	26.3
Tanana	−13.0	−5.0	5.5	23.8	44.3	56.8	58.4	53.3	40.8	22.8	.3	−10.7	23.1
Rampart	−16.3	−7.0	3.9	22.8	44.4	57.3	59.4	54.6	41.3	21.6	−1.2	−11.8	22.4
Allakaket	−24.2	−9.8	−3.7	16.3	41.2	55.9	58.2	51.9	39.0	17.6	−10.7	−18.2	17.8
Fort Yukon	−22.6	−15.1	−.2	20.5	42.8	57.8	61.2	54.7	42.1	20.0	−5.9	−21.3	19.5
Circle	−11.8	−17.7	.6	20.6	42.0	57.4	61.3	54.7	38.0	14.6	−10.3	−12.7	19.7
Eagle	−13.4	−4.1	7.4	26.9	44.7	56.0	59.1	53.5	42.1	25.2	3.6	−10.9	24.2
Dawson	−21.0	−12.0	4.0	27.9	46.1	56.7	59.5	54.3	42.3	25.6	1.4	−14.0	22.6

Absolute maximum and minimum temperatures (°F.)

Station		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Fairbanks		40	47	56	65	86	95	99	90	80	67	48	43	99
		−66	−57	−56	−32	9	28	30	19	11	−21	−54	−59	−66
Tanana		40	43	53	63	82	91	89	90	78	67	38	37	91
		−76	−68	−57	−40	−4	23	29	18	3	−27	−68	−68	−76
Rampart		40	42	52	75	86	97	97	96	85	60	37	37	97
		−68	−64	−49	−33	0	24	31	23	7	−28	−57	−61	−68
Allakaket		32	40	44	53	77	86	88	86	79	45	33	34	88
		−70	−70	−68	−42	−17	27	27	19	−3	−41	−61	−69	−70
Fort Yukon		40	41	50	60	85	100	93	87	79	61	36	37	100
		−67	−70	−50	−41	−3	25	27	22	8	−30	−60	−68	−70
Circle		36	28	38	64	78	84	96	90	84	46	41	32	96
		−66	−58	−55	−32	6	32	35	19	2	−18	−52	−53	−66
Eagle		41	45	56	68	85	92	95	87	79	68	48	42	95
		−75	−74	−56	−38	2	23	25	16	2	−28	−54	−69	−75
Dawson		32	34	48	69	85	91	93	86	77	68	47	32	93
		−68	−62	−47	−33	9	25	29	17	8	−23	−48	−63	−68

Average number of days with temperature 32° or lower

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Fairbanks	31	28	31	29	12	0	0	2	15	29	30	31	234
Tanana	31	28	31	29	15	1	1	4	14	29	30	31	244
Rampart	31	28	31	30	17	1	0	3	17	30	30	31	249
Allakaket	31	28	31	30	22	1	1	6	18	30	30	31	259
Fort Yukon	31	28	31	29	18	1	0	3	15	30	30	31	247
Eagle	31	28	31	29	18	2	1	6	16	28	30	31	251
Dawson	31	28	31	28	14	1	0	3	14	28	30	31	239

Average number of days with temperature—

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Fairbanks:													
Zero or lower	27	20	19	5						5	21	26	120
70° or over					3	16	21	12	1				54
Tanana:													
Zero or lower	25	19	19	7						4	18	25	117
70° or lower					1	14	15	9	0				39
Rampart:													
Zero or lower	28	24	22	8						4	20	27	133
70° or over					2	15	18	11	1				47
Allakaket:													
Zero or lower	30	23	26	16						9	21	28	153
70° or over					1	8	16	10	0				35
Fort Yukon:													
Zero or lower	30	26	17	11						6	23	30	143
70° or over					2	15	19	10	1				47
Eagle:													
Zero or lower	26	20	19	6						3	17	25	116
70° or over					2	17	20	13	1				53
Dawson:													
Zero or lower	27	24	20	6						2	16	29	124
70° or over					2	17	22	12	0				53

Mean monthly and annual precipitation (inches and hundredths)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Fairbanks	0.81	0.47	0.79	0.30	0.57	1.42	1.96	1.91	1.46	0.75	0.71	0.62	11.77
Tanana	.75	.77	.64	.26	.80	1.23	2.36	2.41	1.83	1.07	.70	.68	13.50
Rampart	.63	.61	.44	.21	.51	1.11	1.39	1.59	1.36	.98	.53	.62	9.98
Allakaket	.74	.93	.71	.40	.65	1.20	1.68	1.64	1.41	1.06	.66	.97	12.05
Fort Yukon	.38	.43	.29	.29	.50	.85	1.04	1.17	.70	.60	.30	.32	6.87
Circle	.80	.32	.61	.84	.68	.88	1.89	1.85	1.86	.78	.43	.72	11.65
Eagle	.45	.35	.39	.41	.84	1.50	1.78	2.00	1.28	.79	.51	.42	10.72
Dawson	.84	.76	.51	.54	.90	1.19	1.52	1.51	1.46	1.15	1.11	1.04	12.53

Monthly and annual snowfall (inches and tenths)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Fairbanks	8.7	5.5	9.4	2.6	0.4	0	0	T	0.4	5.6	5.5	8.5	46.6
Tanana	11.3	10.1	10.4	3.1	.6	T	0	0	1.1	8.8	8.0	10.0	63.4
Rampart	10.5	7.7	5.2	1.9	.1	.2	0	0	.9	8.8	7.8	6.3	49.4
Allakaket	13.0	15.8	14.3	6.4	.5	0	0	0	1.2	8.8	10.8	14.6	85.4
Fort Yukon	6.2	7.8	5.0	1.9	.4	0	0	T	1.0	7.1	6.9	5.9	42.2
Circle	5.6	3.6	6.0	5.9	3.1	0	0	0	11.5	7.2	4.8	8.0	55.7
Eagle	7.9	4.2	5.3	3.4	.4	0	0	.3	1.8	7.7	8.0	9.9	48.9
Dawson	8.2	7.7	5.3	1.8	.2	0	0	0	1.5	8.4	12.2	10.5	55.8

Greatest and least monthly and annual precipitation (inches and hundredths)

Station		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Fairbanks:														
	Greatest	3.30	1.24	3.72	0.98	1.38	3.25	4.11	3.70	5.61	2.57	4.65	1.52	18.73
	Least	.05	0	T	T	T	.30	.12	.67	.09	T	.11	.15	7.73
Tanana:														
	Greatest	3.16	3.39	2.90	1.01	1.57	2.20	5.18	3.80	2.32	4.40	3.42	2.68	17.69
	Least	.05	.03	T	0	.16	.20	.57	.74	.35	.22	.03	T	7.85
Rampart:														
	Greatest	1.17	3.65	1.42	1.30	1.04	3.03	3.32	3.38	3.01	2.88	1.43	1.99	15.53
	Least	T	.05	T	T	.04	.15	.43	.46	.18	.03	.04	.00	5.32
Fort Yukon:														
	Greatest	1.95	1.33	.80	3.08	4.60	2.40	1.67	1.47	.56	2.37	.88	1.10	[1]6.87
	Least	.10	.03	.16	T	T	.22	.32	.09	.03	.19	.10	.04	4.14
Eagle:														
	Greatest	1.45	1.23	2.19	1.19	2.87	3.30	2.56	4.73	3.38	2.96	1.27	1.10	13.46
	Least	.09	T	0	0	.18	.37	.46	.61	.01	.07	.07	T	6.30

[1] Annual mean.

TOTAL SOLAR RADIATION AT NEW ORLEANS, LA.

By H. S. MAYERSON and HENRY LAURENS

[Laboratory of Physiology in the School of Medicine, Tulane University of Louisiana, New Orleans, La., September 1934]

In a previous publication from this laboratory [1] we presented data concerning the intensity and spectral distribution of solar radiation in New Orleans from the beginning of 1928 through the first half of 1932. The material included measurements of total solar radiation (direct and diffuse) on a horizontal plane for seven months in 1931 and for eight months in 1932. Additional values have since been obtained for the rest of 1932 and for 1933 and form the basis of this report.

Continuous records of the total solar radiation (direct and diffuse) were obtained using Kimball and Hobbs' pyrheliometer [2] as modified by the Eppley Laboratory, in conjunction with a Richard recording millivoltmeter. The pyrheliometer was calibrated through the kindness of Dr. Kimball at the United States Weather Bureau, Washington, against a Marvin pyrheliometer which had been compared with the Standard Smithsonian pyrheliometer. The measurements were made from a tower built on the roof of the laboratory building, the instrument being about 100 feet above sea level. This building is situated on the college campus about 4 miles away from the business center at latitude 29°56′ N., and longitude 90°7′19″. The atmosphere is reasonably clear of smoke and dust and the pyrheliometer so situated that it receives practically unobstructed radiation from sun and sky throughout the year.

The accompanying tables give the average hourly, daily total, and annual radiation (direct and diffuse) as received on a horizontal plane during 1932 and 1933 for all days (tables 1 and 2) and on clear days only (tables 1A and 2A)[3]. Since the principal factors which modify the amount of total radiation (direct and diffuse) received on the earth's surface at any one locality are the altitude of the sun and the clearness of the sky, tables 1A and 2A reflect more clearly the gradual changes in solar altitude, the regularity of which is disturbed when values for all days, clear and cloudy, are included (tables 1 and 2). A comparison of the values given in tables 1A and 2A shows that, with the exception of the months of September, October, and December, the average amount of daily total radiation (direct and diffuse) on clear days in 1933 was above that obtained in 1932, the average daily amount for the year being 24.7 gr. cal. per square centimeter greater. These differences are due in large measure to the inclusion of days which were relatively but not absolutely cloudless, since, according to the method of estimation, a "clear" day is one in which clouds cover 0.3 or less of the sky. This introduces some discrepancy in the comparison of the data for 1932 and 1933, since the latter year was sunnier than usual (see below) and the large number of clear days in 1933, 117 as compared to 98 in 1932, included more days which could be characterized as "very clear" or practically cloudless.

An analysis of tables 1 and 2 shows a much larger average daily radiation during May, June, August, and December in 1933 than in 1932. This is directly referable to the amount of sunshine. Thus the average percent of sunshine hours, 61 of the possible in 1932 and 62 in 1933, was slightly above the normal or long-term average of 58 percent. (See table 3.) In April, June, and July 1932 the amount of sunshine was considerably above normal, but December with 24 percent was within 1 percent of the least amount on record for that or any other month.

On the other hand, January and February in 1933 were slightly below normal, while the other months were above, with March, June, September, November, and December, 20 percent or more above normal. June was the sunniest month on record. This all-time high value for sunshine combined with a record minimum precipitation of 0.59 inch and an unusually high number of clear days (16) resulted in a record high amount of total radiation, the average daily total, calculated from the records of all days (table 2), being 42.6 gr. cal. per square centimeter greater than the average daily value for June 1932, as calculated for clear days only (table 1A), and 135.8 gr. cal. per square centimeter greater than the June 1932 average for all days (table 1).

The close correlation between the percentage of sunshine (average percent of possible sunshine hours as obtained from Weather Bureau records), average cloudiness, and total radiation are shown in figures 1 and 2. During July and August of both years there was a characteristic drop in the amount of sunshine and in total radiation due to excessive cloudiness and precipitation. This point will be discussed in greater detail below.

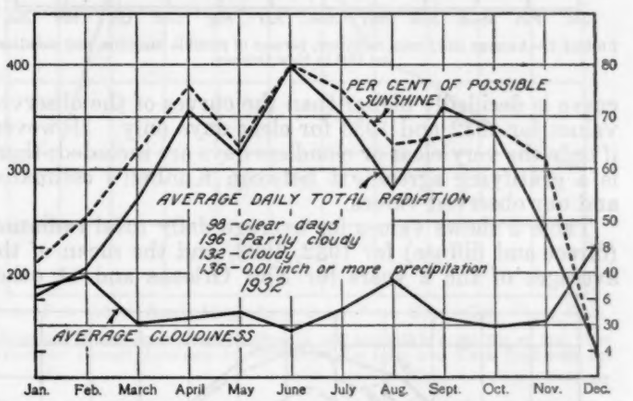


FIGURE 1.—Average daily total radiation, g. cal. per sq. cm., percent of possible sunshine, and cloudiness in tenths of total sky, for 1932 in New Orleans.

The highest value recorded in 1932 was 1.581 gr. cal. per square centimeter per minute on September 28 at 9:50, at which time cumulus clouds were present near, but not obscuring, the sun, and reflection from them undoubtedly accounts for the high value. The absolute maximum for 1933, 1.725 gr. cal. per square centimeter per minute was reached on July 17 at 12:15 p. m. when cumulus clouds again were a factor. The highest hourly average in 1932 was 1.227 gr. cal. per square centimeter per minute from 11 a. m. to 12 m. on October 6; in 1933, 1.345 gr. cal. per square centimeter per minute between 11 a. m. and 12 m. on June 10. The highest daily total for 1932, 549 gr. cal. per square centimeter, was recorded on October 6, 1932; the maximum in 1933, 651 gr. cal. per square centimeter on June 18.

From data obtained at Washington, D. C., Madison, Wis., Lincoln, Nebr., and Santa Fe, N. Mex., Kimball in

[1] Laurens, H. and H. S. Mayerson, Intensity and Spectral Distribution of Solar Radiation in New Orleans. Jour. Optical Soc. Amer., 1933, 23, 133.

[2] Kimball, H. H. and H. E. Hobbs, A new Form of Thermoelectric Recording Pyrheliometer. Ibid., 1923, 7, 707.

[3] The number of clear days for each year was obtained from the Annual Meteorological Summary published by the New Orleans Weather Bureau office. With the exception of the readings for total radiation, which were done by us in our laboratory, all other weather data mentioned in this report were obtained from publications of the local Weather Bureau office or from appropriate numbers of MONTHLY WEATHER REVIEW.

1919 [4] calculated the intensity of the radiation received on a horizontal surface and the total radiation per day for latitudes 30°, 36°, 42°, and 48° N. Values for total daily radiation on a horizontal surface on cloudless days in New Orleans (and other cities) are given in his table 9A under the heading "Latitude 30° N. (Gulf coast)" and are graphically reproduced in figure 3 of this paper. The

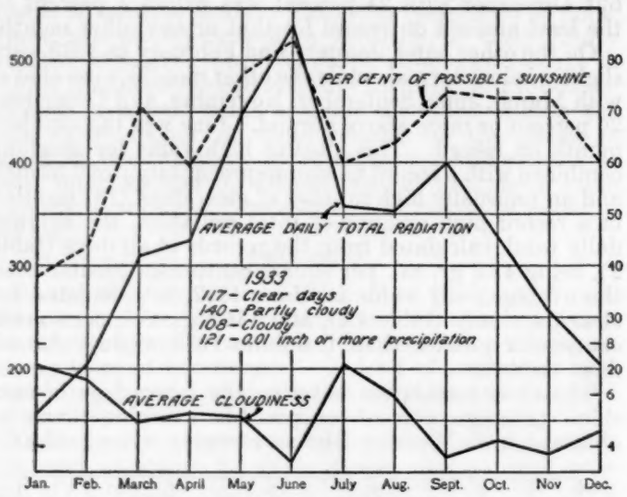


FIGURE 2.—Average daily total radiation, percent of possible sunshine, and cloudiness for 1933 in New Orleans.

curve is decidedly higher than the curves of the observed values for 1932 and 1933 for clear days only. However, if only the very clear or cloudless days are included, there is a gratifying agreement between Kimball's estimated and our observed values.

Table 5 shows values for average daily total radiation (direct and diffuse) for 1932, 1933, and the mean of the averages of the 2 years for New Orleans and 11 other

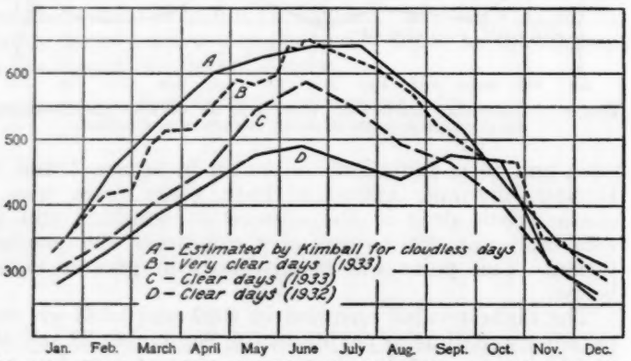


FIGURE 3.—Comparison of estimated (Kimball) and observed average daily total radiation in New Orleans in g. cal. per sq. cm. per min.

cities as calculated from data published in volumes 60 and 61 of the MONTHLY WEATHER REVIEW. Figure 4 shows the respective annual totals in kilogram calories per square centimeter. Table 4 [5] indicates the location of the various stations and the instruments used. Since all of the pyrheliometers (except at Miami) have been calibrated against the Marvin pyrheliometer no. 3, at the Weather Bureau in Washington, the figures are absolutely comparable. The Callendar instrument at Miami probably reads about 3.5 percent lower than the rest.[6]

Of considerable interest are the relatively small amounts of total radiation received during the summer months by stations situated at about latitude 30° as compared with the more northern cities (figs. 5, 6, 7). This is particularly striking in New Orleans, which, as a matter of fact, received less total radiation during July and August of 1932 and 1933 than any of the stations reporting (excepting Gainesville in 1932). This is chiefly due to the extreme distortion of the distribution of rainfall, in the form of thunder showers caused by convectional overturning, which is characteristic of these months. McDonald [7], from an analysis of hourly rainfall in New Orleans for the 30-year period from 1898 through 1927, has pointed out that during June, July, and August there is some rain 10 to 14 percent of the time between noon and 4 p. m. This is in contrast to 4 to 6 percent during April and May, and to 4 to 7 percent during October and November during the same hours. During the winter the rains are well distributed around the hours of the day, but during

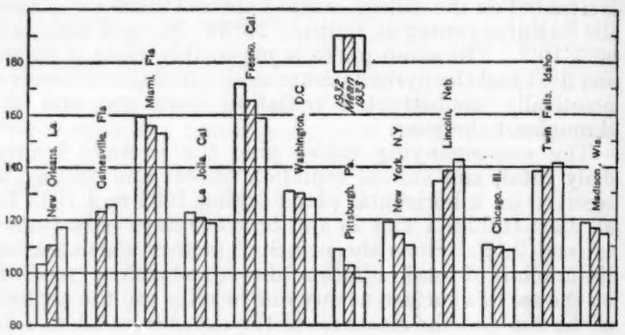


FIGURE 4.—Total annual radiation on a horizontal plane in kilogram calories per sq. cm.

the hot months most of the measurable rainfall is recorded between 9 a. m. and 7 p. m. The rainiest hour of the year in New Orleans, judged by the traces and measurable hours, is the hour from noon to 1 p. m. in July, when rain conditions enter the record about 1 day in 4. Rains occur with almost the same frequency during the hours between noon and 2 p. m. in August. Since these thundershowers are usually preceded and followed by a period of several hours of cumulus cloud formation, the loss in radiation is considerable.

A comparison of the values given in table 5 with those given by Kimball shows clearly that while the total amount of radiation received in different localities can be estimated with reasonable accuracy for cloudless days (as we have shown above for New Orleans), such estimations are of limited value as compared to the averages of all days, clear and cloudy, as obtained by actual measurement at the particular station and reflecting the conditions peculiar to that locality. The measurements in New Orleans are being continued and will be summarized again when sufficient additional data have been accumulated.

[4] Kimball, H. H., Variation in the Total and Luminous Solar Radiation with Geographical Position in the United States. MONTHLY WEATHER REVIEW, 1919, 47, 769.

[5] Rearranged from table given by Kimball, H. H., Solar Radiation Measurements. MONTHLY WEATHER REVIEW, 1932, 60, 26.

[6] Kimball, H. H., Solar Radiation Measurements. MONTHLY WEATHER REVIEW, 1932, 60, 26.

[7] McDonald, W. F., Hourly Frequency and Intensity of Rainfall at New Orleans, La. MONTHLY WEATHER REVIEW, 1929, 57, 1.

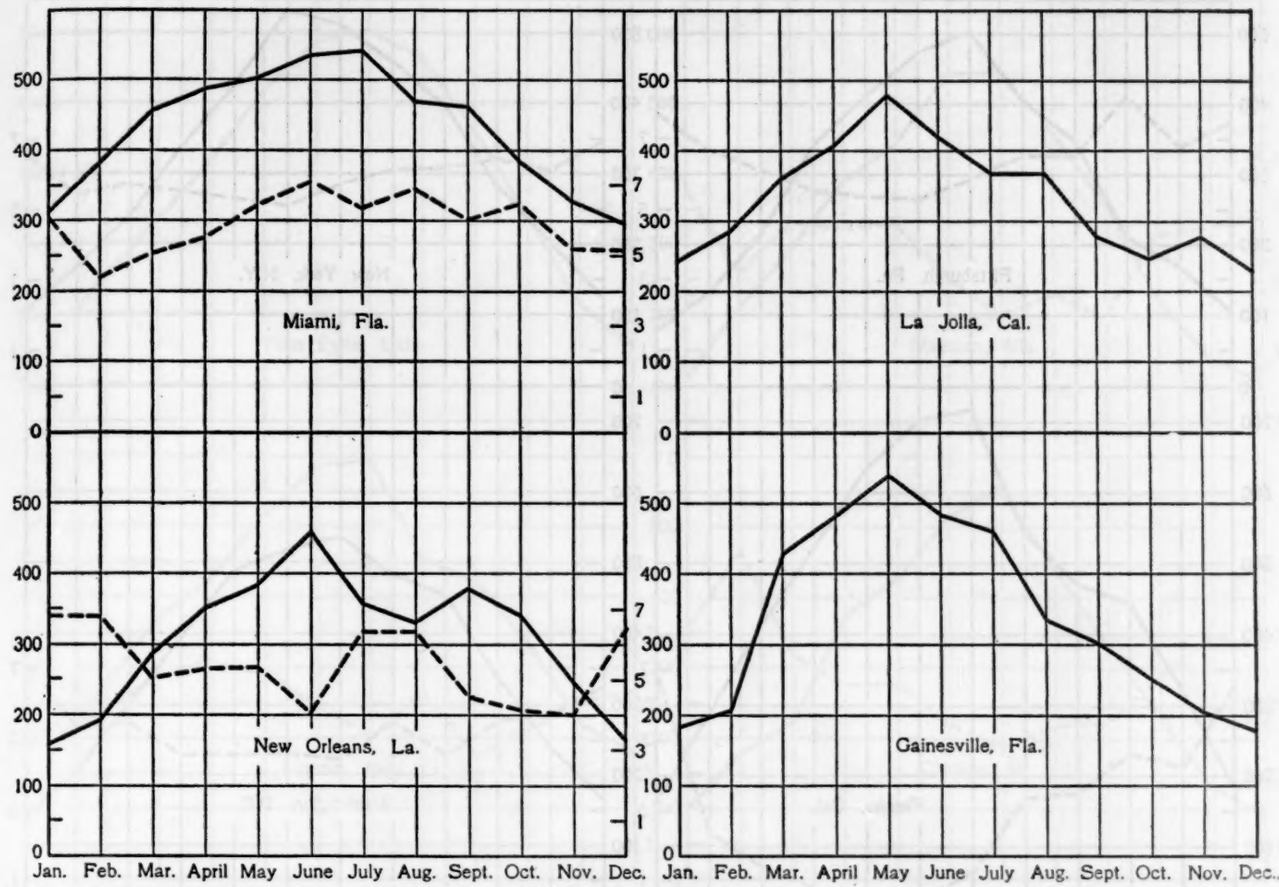

Miami, Fla.
New Orleans, La.
La Jolla, Cal.
Gainesville, Fla.
Jan. Feb. Mar. April May June July Aug. Sept. Oct. Nov. Dec.
Jan. Feb. Mar. April May June July Aug. Sept. Oct. Nov. Dec.

FIGURE 5.—The upper curves represent the means of the values for total daily radiation (direct and diffuse) on a horizontal plane for 1932 and 1933 in g. cal. per sq. cm. The lower curves are similar means of the average cloudiness in tenths of clouded sky. Values for average cloudiness for Gainesville, La Jolla, and Twin Falls were not available.

TABLE 1.—*Average amount of total radiation (direct and diffuse) received on a horizontal surface in gr. cal. per square centimeter per minute. All days, 1932*

Hour ending (apparent time)	7	8	9	10	11	12	1	2	3	4	5	6	Average daily total gr. cal./cm.²
January		0.053	0.156	0.302	0.422	0.515	0.486	0.423	0.329	0.212	0.089		179.2
February	0.010	.089	.237	.422	.512	.495	.472	.439	.376	.247	.124	0.017	206.4
March	.034	.150	.315	.472	.585	.637	.650	.619	.493	.348	.184	.051	272.3
April	.098	.277	.460	.644	.830	.767	.735	.721	.605	.447	.261	.097	356.5
May	.110	.215	.447	.588	.656	.734	.698	.564	.493	.358	.249	.115	313.6
June	.262	.467	.632	.706	.809	.804	.787	.703	.587	.447	.285	.166	399.3
July	.155	.387	.589	.683	.762	.738	.626	.546	.491	.400	.300	.207	353.0
August	.123	.293	.479	.558	.621	.587	.562	.499	.381	.285	.201	.104	281.6
September	.150	.353	.550	.650	.732	.764	.782	.691	.575	.393	.271	.064	359.0
October	.076	.235	.453	.623	.758	.776	.768	.681	.560	.411	.222	.064	337.6
November	.017	.114	.264	.428	.533	.620	.626	.585	.455	.271	.101	.017	241.9
December	.005	.050	.135	.231	.324	.365	.336	.280	.198	.114	.041	.004	125.0
Average for year	.087	.224	.393	.526	.629	.650	.627	.563	.462	.328	.194	.076	285.5

TABLE 2.—*Average amount of total radiation (direct and diffuse) received on a horizontal surface in gr. cal. per square centimeter per minute. All days, 1933*

Hour ending (apparent time)	7	8	9	10	11	12	1	2	3	4	5	6	Average daily total gr. cal./cm.²
January	0.001	0.034	0.137	0.268	0.398	0.450	0.438	0.393	0.297	0.195	0.089	0.013	162.8
February	.005	.061	.167	.301	.446	.516	.476	.505	.408	.302	.155	.032	202.3
March	.024	.153	.323	.497	.640	.715	.758	.680	.575	.437	.247	.080	307.7
April	.088	.220	.396	.557	.657	.739	.780	.724	.516	.410	.253	.098	326.3
May	.160	.372	.576	.780	.878	.935	.985	.885	.787	.594	.360	.170	448.9
June	.274	.447	.707	.829	.953	1.079	1.074	1.001	.848	.660	.830	.217	535.1
July	.189	.378	.499	.562	.692	.641	.747	.772	.674	.466	.344	.172	367.8
August	.143	.351	.527	.627	.714	.771	.728	.727	.576	.458	.284	.124	361.8
September	.132	.350	.573	.740	.837	.886	.852	.763	.684	.476	.273	.100	400.0
October	.066	.226	.417	.609	.749	.838	.816	.745	.533	.327	.146	.036	330.5
November	.019	.133	.310	.473	.619	.728	.712	.621	.447	.228	.063	.001	261.2
December	.009	.066	.200	.384	.505	.531	.575	.516	.393	.228	.075	.003	209.1
Average for year	.092	.233	.403	.552	.674	.736	.745	.694	.562	.398	.260	.087	326.2

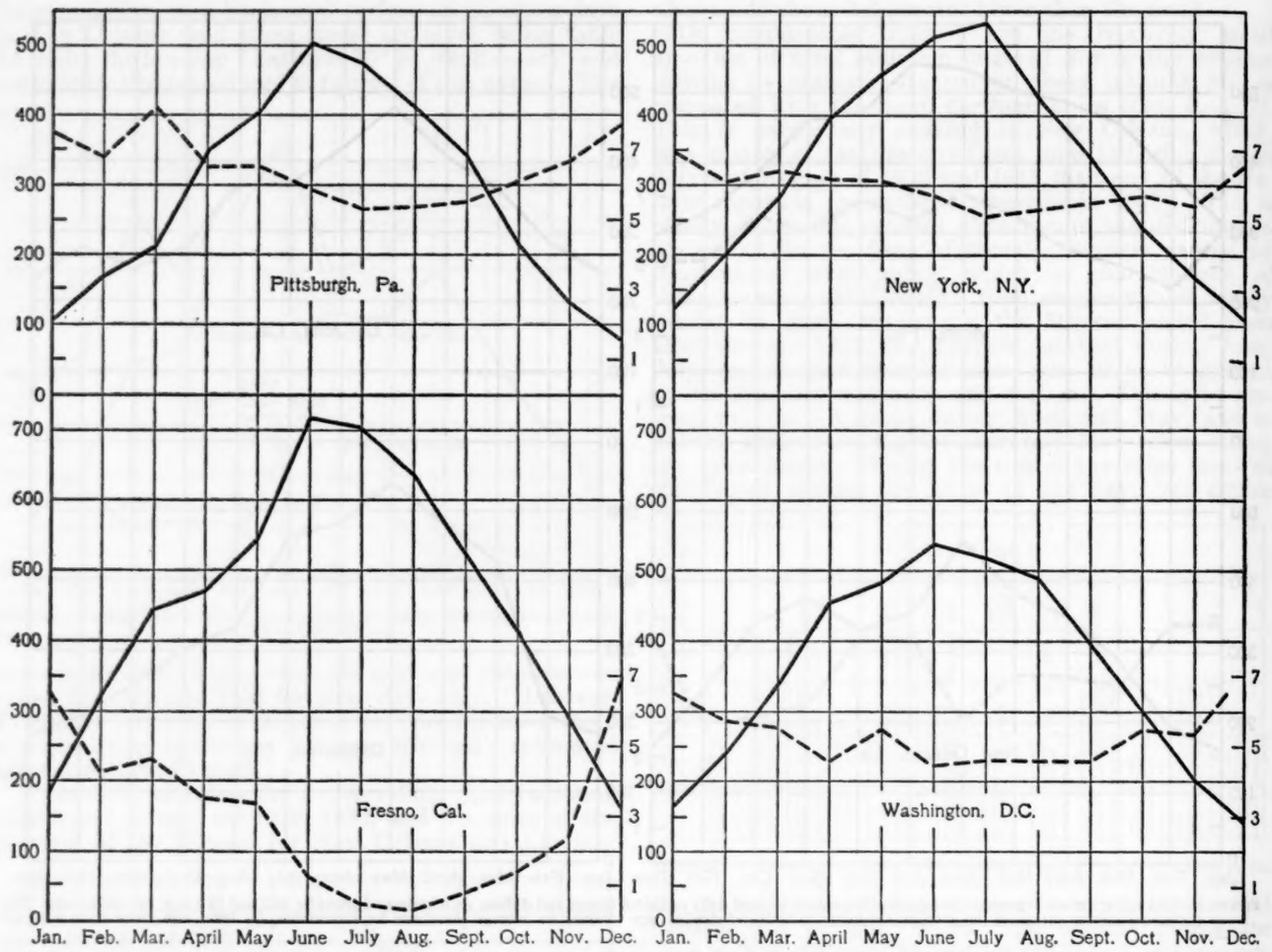


FIGURE 6.—The upper curves represent the means of the values for total daily radiation (direct and diffuse) on a horizontal plane for 1932 and 1933 in g. cal. per sq. cm. The lower curves are similar means of the average cloudiness in tenths of clouded sky. Values for average cloudiness for Gainesville, La Jolla, and Twin Falls were not available.

TABLE 1A.—*Average amount of total radiation (direct and diffuse) received on a horizontal surface in gr. cal. per square centimeter per minute. Clear days only (total=98), 1932*

Hour ending (apparent time)	7	8	9	10	11	12	1	2	3	4	5	6	Average daily total gr. cal./cm.²
January	.....	0.082	0.259	0.484	0.704	0.805	0.836	0.768	0.591	0.376	0.150	.....	280.5
February	0.018	.155	.374	.606	.746	.834	.803	.720	.595	.415	.217	.029	330.7
March	.044	.208	.452	.687	.863	.930	.905	.862	.700	.480	.264	.053	386.8
April	.114	.325	.574	.779	.932	1.002	.947	.881	.716	.502	.292	.102	430.0
May	.178	.426	.645	.780	.961	1.072	1.023	.889	.778	.620	.396	.166	476.0
June	.239	.484	.682	.790	.978	1.057	1.052	.935	.804	.594	.377	.186	492.5
July	.224	.440	.628	.810	.958	1.057	1.031	.893	.665	.553	.333	.165	465.4
August	.154	.397	.625	.786	.950	1.023	.980	.941	.642	.468	.262	.144	442.3
September	.177	.470	.689	.841	.962	1.039	1.021	.968	.798	.573	.307	.108	477.2
October	.105	.321	.595	.843	1.013	1.091	1.071	.968	.796	.604	.340	.095	470.5
November	.016	.149	.374	.590	.737	.816	.809	.709	.538	.320	.124	.019	312.1
December	.013	.132	.341	.549	.704	.764	.745	.596	.401	.204	.050	.000	269.9
Average for year	.109	.299	.520	.712	.876	.958	.910	.844	.669	.476	.260	.089	403.0

TABLE 2A.—*Average amount of total radiation (direct and diffuse) received on a horizontal surface in gr. cal. per square centimeter per minute. Clear days only (total=117), 1933*

Hour ending (apparent time)	7	8	9	10	11	12	1	2	3	4	5	6	Average daily total gr. cal./cm.²
January	0.004	0.067	0.268	0.499	0.716	0.840	0.833	0.719	0.559	0.374	0.146	0.016	302.5
February	.003	.073	.259	.538	.759	.895	.921	.842	.711	.503	.248	.057	348.5
March	.025	.172	.422	.635	.855	.982	.905	.908	.763	.572	.313	.110	405.1
April	.126	.353	.586	.807	.965	1.055	1.041	.939	.765	.532	.289	.086	452.6
May	.202	.484	.747	.953	1.120	.995	1.224	1.139	.907	.663	.448	.211	545.6
June	.285	.531	.809	.950	1.112	1.244	1.193	1.128	.964	.777	.531	.250	586.4
July	.206	.457	.685	.745	1.075	1.186	1.212	1.110	1.041	.784	.456	.229	551.2
August	.136	.383	.649	.813	.972	1.016	1.040	1.052	.968	.719	.343	.117	492.5
September	.143	.364	.608	.812	.959	1.042	1.046	.945	.830	.587	.303	.112	465.5
October	.000	.289	.504	.799	.956	1.017	.998	.893	.647	.376	.170	.056	407.3
November	.024	.153	.362	.590	.770	.867	.864	.742	.551	.269	.076	.000	316.1
December	.015	.091	.265	.482	.650	.680	.726	.623	.472	.234	.072	.001	258.7
Average for year	.105	.276	.514	.719	.908	.985	1.008	.920	.765	.533	.283	.103	427.7

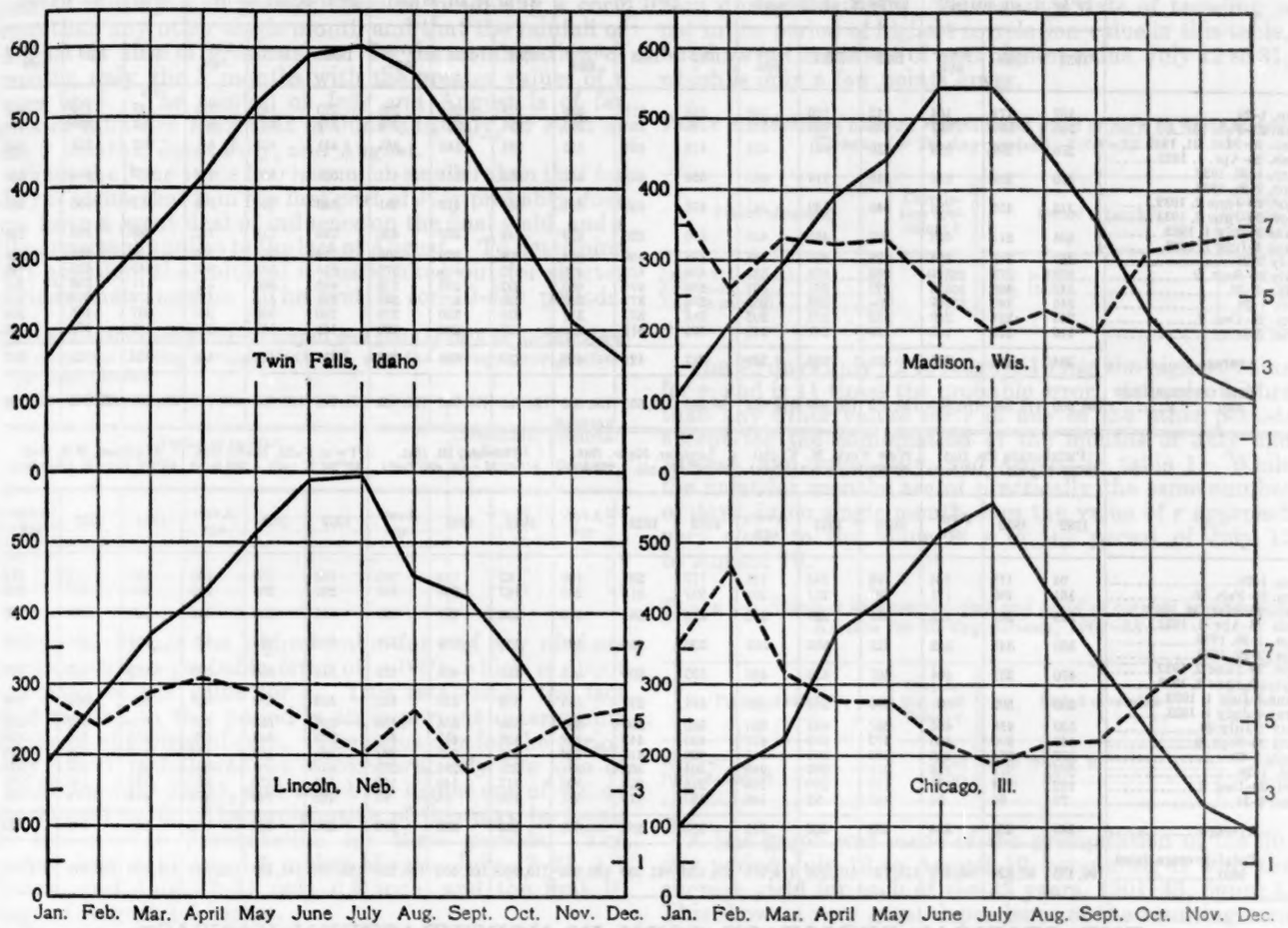


FIGURE 7.—The upper curves represent the means of the values for total daily radiation (direct and diffuse) on a horizontal plane for 1932 and 1933 in g. cal. per sq. cm. The lower curves are similar means of the average cloudiness in tenths of clouded sky. Values for average cloudiness for Gainesville, La Jolla, and Twin Falls were not available.

TABLE 3.—*Average and extreme values for New Orleans*

[From Annual Meteorological Summary, Weather Bureau, 1933]

Month	Precipitation average (total inches)	Sunshine: Total percent of hours possible	Sunshine: Highest percent of	Sunshine: Lowest percent of	Average number of days: Clear	Partly cloudy	Cloudy	Rain 0.01 inch or more	Thunderstorms
Number of years	63	43	43	43	63	63	63	63	34
January	4.57	159	49	77	28	9	10	12	10	2
February	4.39	159	50	72	23	9	9	10	9	3
March	5.09	212	57	92	26	11	10	10	9	4
April	5.27	240	63	86	26	11	11	8	7	4
May	4.87	283	67	85	44	12	13	6	9	7
June	5.73	266	63	84	37	9	15	6	13	11
July	6.54	244	57	81	31	7	16	8	15	15
August	5.91	234	57	86	24	7	17	7	14	15
September	5.23	235	64	89	32	12	12	6	10	8
October	3.48	237	67	87	39	16	9	6	7	2
November	3.57	185	59	81	33	13	9	8	7	1
December	4.69	142	45	68	23	9	9	13	11	2
Year	59.34	2,594	58	71	45	125	140	100	121	74

TABLE 4.—*Location of stations and instruments used*

Stations	Instruments	Registers	Latitude	Longitude	Altitude
			° ′	° ′	*Feet*
New Orleans, La.	Eppley	Richard	29 56 N.	90 07 W.	100
Gainesville, Fla.	Moll	do	29 39 N.	84 21 W.	233
Miami, Fla.	Callendar	Callendar	25 41 N.	80 12 W.	
La Jolla, Calif.	Weather Bureau	Engelhard	32 50 N.	117 15 W.	85
Fresno, Calif.	Eppley	do	36 43 N.	119 49 W.	80
Washington, D. C.	Marvin		38 56 N.	77 05 W.	397
	Eppley	Engelhard			414
Pittsburgh, Pa.	do	do	40 32 N.	80 02 W.	1,114
New York, N. Y.	do	do	40 46 N.	73 58 W.	155
Lincoln, Nebr.	Marvin		40 50 N.	96 41 W.	1,225
	Callendar	Callendar			1,250
Chicago, Ill.	Eppley	Engelhard	41 47 N.	87 35 W.	688
Twin Falls, Idaho	do	do	42 29 N.	114 25 W.	4,300
Madison, Wis.	Marvin		43 05 N.	89 23 W.	974
	Callendar	Callendar			1,000

TABLE 5.—*Average daily total radiation (direct and diffuse) received on a horizontal plane in gr. cal. per square centimeter*

	New Orleans, La. (lat. 29°56′ N; alt. 100 feet)			Gainesville, Fla. (lat. 29°39′ N; alt. 233 feet)			Miami, Fla. (lat. 25°41′ N)			La Jolla, Calif. (lat. 32°50′ N; alt. 85 feet)			Fresno, Calif. (lat. 36°43′ N; alt. 330 feet)			Washington, D. C. (lat. 38°56′ N; alt. 414 feet)		
	1932	1933	Average	1932	1933	Average	1932	1933	Average	1932	1933	Average	1932	1933	Average	1932	1933	Average
Jan. 1–28	157	171	164	242	130	186	344	275	310	278	214	246	210	148	179	143	179	161
Jan. 29–Feb. 25	194	199	197	233	178	205	409	356	383	291	287	289	322	327	325	212	268	240
Feb. 26–Mar. 31, 1932 / Feb. 26–Apr. 1, 1933	276	299	288	432	431	432	472	438	455	384	346	365	441	455	447	332	347	340
Apr. 1–28, 1932 / Apr. 2–29, 1933	370	338	354	545	414	485	534	439	487	481	341	411	558	389	474	473	445	459
Apr. 29–June 2, 1932 / Apr. 30–June 3, 1933	315	456	386	546	539	543	492	509	501	557	412	481	653	444	549	512	459	486
June 3–July 1, 1932 / June 4–July 1, 1933	404	511	458	507	465	486	526	539	533	442	397	420	729	714	722	489	582	536
July 2–29	359	349	354	536	385	461	584	498	541	408	329	369	714	706	710	528	517	523
July 30–Sept. 2	288	373	331	262	404	333	465	475	470	312	411	372	645	635	640	540	445	493
Sept. 3–30	347	408	378	222	381	302	436	494	465	232	324	278	498	556	527	441	358	400
Oct. 1–28	346	348	347	204	302	253	397	377	387	220	277	249	421	413	417	277	319	298
Oct. 29–Dec. 2	249	254	250	132	275	203	314	339	327	238	320	279	290	300	295	227	185	206
Dec. 3–31	116	213	165	110	247	178	275	311	293	198	260	229	168	153	161	147	134	141
Average	284	322	303	331	346	339	437	421	429	339	326	333	471	437	454	360	353	357
Total (average times 365)	103, 660	117, 530	110, 595	120, 815	126, 290	123, 552	159, 505	153, 665	156, 585	123, 735	118, 990	121, 363	171, 915	159, 505	165, 710	131, 400	128, 845	130, 305

	Pittsburgh, Pa. (lat. 40°32′ N.; alt. 1,114 feet)			New York, N. Y. (lat. 40°46′ N.; alt. 156 feet)			Lincoln, Nebr. (lat. 40°50′ N.; alt. 1,250 feet)			Chicago, Ill. (lat. 41°47′N.; alt. 688 feet)			Twin Falls, Idaho (lat. 42°29′ N.; alt. 4,300 feet)			Madison, Wis. (lat. 43°05′ N.; alt. 1,009 feet)		
	1932	1933	Average	1932	1933	Average	1932	1933	Average	1932	1933	Average	1932	1933	Average	1932	1933	Average
Jan. 1–28	94	113	104	96	145	121	177	201	189	85	119	102	159	160	160	100	131	116
Jan. 29–Feb. 25	161	180	171	191	211	201	257	315	286	167	203	185	261	263	262	209	227	218
Feb. 26–Mar. 31, 1932 / Feb. 26–Apr. 1, 1933	235	201	213	291	269	280	375	364	370	236	221	229	311	369	340	326	264	295
Apr. 1–28, 1932 / Apr. 2–29, 1933	360	343	352	421	365	393	390	460	425	393	359	378	436	385	417	430	354	392
Apr. 29–June 2, 1932 / Apr. 30–June 3, 1933	470	337	404	507	412	460	529	500	515	455	403	429	513	536	525	466	423	445
June 3–July 1, 1932 / June 4–July 1, 1933	500	502	501	490	545	518	541	637	589	518	526	522	596	582	589	532	563	548
July 2–July 29	509	458	484	567	463	535	580	599	590	549	556	553	597	605	601	570	522	546
July 30–Sept. 2	449	390	420	472	382	427	455	443	449	433	457	440	572	564	568	432	489	461
Sept. 3–30	377	274	346	380	309	345	429	416	424	378	295	337	461	462	462	397	319	358
Oct. 1–28	218	213	216	211	269	240	304	363	334	211	239	225	310	364	337	197	250	224
Oct. 29–Dec. 2	132	124	128	175	160	168	215	228	222	113	146	130	181	232	207	132	150	141
Dec. 3–31	79	80	80	119	92	106	187	175	181	110	76	93	163	143	153	119	99	109
Average	299	268	284	328	302	315	370	392	381	304	300	302	380	389	385	327	316	322
Total (average times 365)	109, 135	97, 820	103, 478	119, 720	110, 230	114, 975	135, 050	143, 080	139, 065	110, 960	109, 500	110, 230	138, 700	141, 985	140, 340	119, 350	115, 340	117, 345

THE CRITICAL PERIOD OF CORN IN NORTHEASTERN KANSAS

By A. D. ROBB

[Weather Bureau office, Topeka, Kans., July 1934]

This paper is an endeavor to correlate rainfall and the yield of corn in northeastern Kansas, to determine when rain is of the most value and what effect it has on the crop in this section.

The 11 counties, Marshal, Riley, Nemaha, Jackson, Pottawatomie, Brown, Doniphan, Atchison, Jefferson, Leavenworth, and Wyandotte comprise the area for this study. They are the chief corn-producing counties of the State. Statistics of crop yields and precipitation data used are both official, one being obtained from the Bureau of Agricultural Economics and the other compiled by the Weather Bureau. The period used was the 33 years, 1901 to 1933, inclusive.

The method used is familiar and there is no need to explain it here, except to reiterate the fact that the nearer the correlation coefficient, r, approaches 1 the closer the relation, and the nearer it approaches 0 the less the relation. Some writers believe that the influence of one factor upon another is well established if the correlation coefficient is 3 times the probable error, while others think that it should be 6 times that value. It is better to assume that there may be some connection if the correlation coefficient is 3 times the probable error and that the relation is established beyond question if it is more than 6 times that error. Correlation coefficient tables have been worked out according to this method for the 33-year period in northeastern Kansas, first for calendar months and then for other periods.

TABLE 1.—*Relation between rainfall and corn yields in northeastern Kansas by months, 1901–33*

Period of rainfall	Correlation coefficient, r	Period of rainfall	Correlation coefficient, r
May	+0.01	September	+0.05
June	+0.30	June and July	+0.61
July	+0.58	July and August	+0.80
August	+0.51	June, July, and August	+0.74

The value of r for July is nearer the whole number 1 than that of any other single month. However, it is followed very closely by that of August, indicating that the rainfall of July is of greater effect in producing a corn crop than any other single month and that the rainfall of August is also of great value. In the combination of months only the 3 months with the greater values of r were used. The rainfall of July and August is of far greater influence than that of June and July, or even of the 3 months, June, July, and August.

Since the June value for r is so much smaller than that for July it seems that rain the first part of July probably does not have a great deal of influence on the final yield, and a like argument applies to the last of August. To determine this question, the value of r was worked out for shorter periods than months. The first is for 10-day periods.

TABLE 2.—*Relation between rainfall and yield of corn in northeastern Kansas for 10-day periods, 1901–33, and the average precipitation for each period*

Period of rainfall	Correlation coefficient r	Average precipitation (inches)
July 2–11	+0.23	1.5
July 12–21	+.51	1.1
July 22–31	+.30	0.9
Aug. 1–10	+.44	1.5
Aug. 11–20	+.24	1.4
Aug. 21–30	+.22	1.0

July 12–21 has the highest value for r of any of these periods, with a probable error of ± 0.09, which is about one-sixth of the value for r. This establishes the fact that rainfall in this period is an important determining factor in the yield of corn. The value of r for the period July 12–21 is followed by a comparatively low one of +0.30 for July 22–31, and that by a higher one of +0.44 for August 1–10. The explanation of this may be found in the average precipitation for these periods. The period July 2–11 has 1.5 inches of rain, July 12–21, 1.1 inches, and July 22–31 only 0.9 inch, and the first 10 days of August 1.5 inches.

From the Weekly Weather and Crop Bulletin of past years July 14 was found to be the average date of tasseling in this area, which is in the period of the highest value for r. This date is also so near the period of the greatest average rainfall that the influence of the rains earlier in the season is still felt.

Also, it may be that 10 days is not a long enough drought to damage the corn seriously, especially if followed immediately by good rains. The year 1917 illustrates this very well. During the month of July the average precipitation for this section of Kansas was only 0.78 inch, with corresponding high temperatures. An excerpt taken from the Climatological Data for Kansas, July 1917, states, "Corn * * * was badly damaged by the high temperatures, excessive sunshine, and hot winds of the last decade." Rains began the first day of August and the average over this area for the first 10 days of August was 2.65 inches. The sequel to the statement of the effect of the July weather on corn is taken from the August 1917 number of Climatological Data: "The revival of crops after the rains began was almost magical. The corn crop took on new growth * * *." The average yield in this section was 25.8 bushels per acre, just 0.5 bushel above the average.

The highest value for r in table 3 is +0.61 for the 20 days July 22 to August 10, which is nine times the probable error and shows very clearly the effect of rain on corn during this time. The average date of tasseling is not in the period of highest correlation value in this table, but does fall in the one of next highest value, July 12 to 31, which is only a few points lower.

TABLE 3.—*Relation between rainfall and yield of corn in northeastern Kansas for 20-day periods, 1901–33*

Period of rainfall	Correlation coefficient r	Period of rainfall	Correlation coefficient r
July 2–21	+0.39	Aug. 1–20	+0.44
July 12–31	+.54	Aug. 11–30	+.32
July 22–Aug. 10	+.61		

The 30 days July 12 to August 10 has the highest value for r, and is 11 times the probable error. It is also higher than any other values for r in any of the other periods except for the combination of the months of July and August, and June, July, and August in table 1. While the calendar months are of practically the same number of days, in no single month does the value of r approach very close to the value of r in the period of July 12 to August 10.

TABLE 4.—*Relation between rainfall and yield of corn in northeastern Kansas for 30-day periods, 1901–33*

Period of rainfall	Correlation coefficient r	Period of rainfall	Correlation coefficient r
July 2–31	+0.58	July 22–Aug. 20	+0.60
July 12–Aug. 10	+.69	Aug. 1–30	+.52

A line graph was made of the precipitation of the 30-day period July 12 to August 10, comparing it with the average yield for each of the 33 years, 1901–33, figure 1. This shows a very great dependence of the resulting corn yield on the precipitation of this period.

A bar graph of the precipitation of this 30-day period and the average corn yield was also prepared, figure 2. The precipitation was arranged in order of amounts beginning with the lowest. It is very evident that in some cases there are other factors outside the rainfall of the period July 12 to August 10 that influence the yield of corn. The most notable is the comparison of the years 1901 and 1902. There was almost the same amount of rain in the 30 days of 1901 as there was in the corresponding time of 1902 but the yield was in no way comparable. The period of July 12 to August 10 of 1901 was preceded by a hot dry June and excessively hot weather the fore part of July. The rains did not come till near the close of July. The same period of 1902 was preceded by a June of abundant rainfall and good rains also during the first of July. The corn crop was damaged beyond recovery by the hot, dry weather of June and July in 1901 before the rains came.

In the 18 years that the precipitation of this 30-day period has been below the average, only 5 have resulted in a crop above the average. In the 15 years when the precipitation has been above the average only once has the resulting yield of corn been below the average.

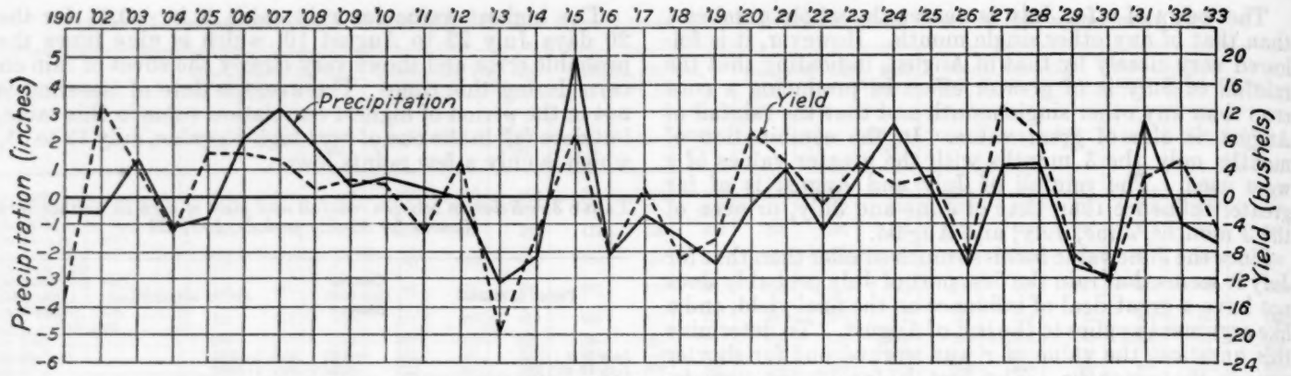


FIGURE 1.—Line graphs of precipitation of the 30-day period July 12 to August 10, compared with the average corn yield, 1901–33.

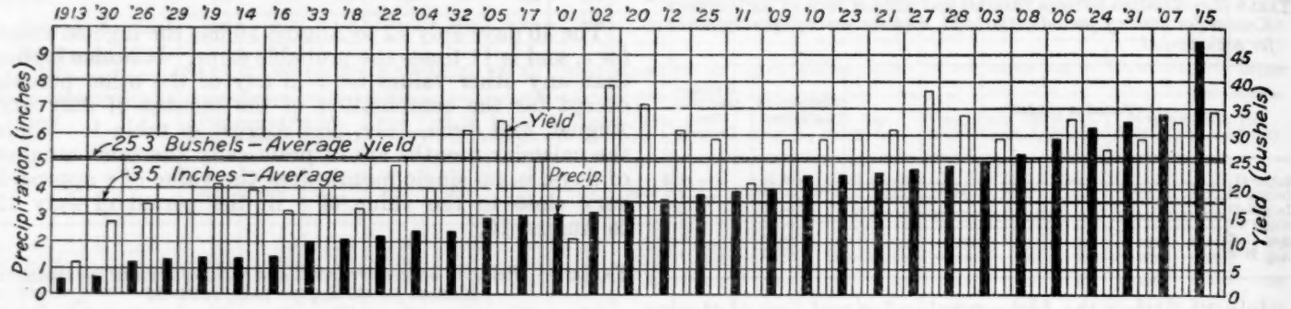

1913 '30 '26 '29 '19 '14 '16 '33 '18 '22 '04 '32 '05 '17 '01 '02 '20 '12 '25 '11 '09 '10 '23 '21 '27 '28 '03 '08 '06 '24 '31 '07 '15
Precipitation (inches)
Yield (bushels)
25 3 Bushels—Average yield
35 Inches—Average
Yield
Precip.

FIGURE 2.—Bar graph of the precipitation for northeastern Kansas for the period July 12 to August 10, arranged in order of amounts, compared with the average corn yield, for the years 1901–33.

TABLE 5.—*Average precipitation, July 12 to August 10, 1901–33 over northeastern Kansas, grouped according to amounts and compared with the average yield per acre*

Year	Average precipitation	Average yield in bushels per acre
1913	0.4	5.6
1930	.6	14.3
Total	1.0	19.9
Average	.5	10.0
1926	1.1	16.8
1929	1.2	17.6
1919	1.3	20.2
1914	1.4	19.0
1916	1.4	16.1
Total	6.4	89.7
Average	1.3	17.9
1933	2.0	20.0
1918	2.1	16.3
1922	2.2	24.3
1904	2.4	20.4
1932	2.4	31.4
1905	2.9	33.2
Total	14.0	145.6
Average	2.3	24.3
1917	3.0	25.8
1901	3.1	11.0
1902	3.1	39.5
1920	3.4	35.2
1912	3.5	31.3
1925	3.7	28.9
1911	3.8	20.8
Total	23.6	192.5
Average	3.4	27.5
1909	4.0	28.5
1910	4.3	28.4
1923	4.3	30.0
1921	4.5	30.5
1927	4.7	38.0
1928	4.7	33.8
Total	26.5	189.2
Average	4.4	31.5
1903	5.0	29.0
1908	5.3	26.0
1906	5.8	33.5
Total	16.1	88.5
Average	5.4	29.5
1924	6.2	27.6
1931	6.2	28.9
1907	6.7	32.5
Total	19.1	89.0
Average	6.4	29.7
1915, total	8.5	34.6

This table shows how much the yield of corn in northeastern Kansas is dependent on the rainfall of July 12 to August 10. On the average if there is less than an inch of rain in that time the yield will be about 10 bushels. If there is from 1 to 2 inches the yield is increased to 18 bushels. When there is between 2 and 3 inches of rain the yield is further increased to about 24 bushels per acre. When there is from 3 to 4 inches of rain the yield is increased further by only 4 bushels per acre. If there is between 4 and 5 inches of rain the yield is again increased about 4 bushels per acre, making an average yield of 32 bushels. Six years have had between 5 and 7 inches of rain and the yield dropped to about 30 bushels per acre on the average. One year had 8.5 inches of rain in this period and the average yield that year was 35 bushels per acre. In general, the more rain there is in the 30-day period July 12 to August 10 in northeastern Kansas the greater the resulting yield of corn.

TABLE 6.—*Time of planting of corn and the departure from the average yield for 20 years*

	Departure from average yield	
Years corn was planted on or before May 4:		
1901		−14.7
1902	+13.8	
1903	+3.3	
1905	+7.5	
1920	+9.5	
1921	+4.8	
1922		−14.7
1923	+4.3	
1924	+1.9	
1925	+3.2	
1926		−8.9
Years corn was planted after May 4:		
1904		−5.3
1919		−5.5
1927	+12.3	
1928	+8.1	
1929		−8.1
1930		−11.4
1931	+8.2	
1932	+5.7	
1933		−5.7

The data of table 6 were compiled from the Weekly Weather and Crop Bulletins for Kansas. It is the nearest approach to the time of planting that could be found for this section and covers the years 1901–05, and 1919–33, inclusive.

The average date of planting corn was found to be May 4. Corn has been planted on or before May 4, 11 times and after that date 9 times out of the 20 years used in this comparison. Eight of the eleven years when corn was planted on or before May 4 gave yields above the average and 3 below. In the 9 years that corn was planted after May 4, the crop was above the average four times and below five times. By planting corn in this section before May 4 there is an advantage of 3 to 1 that the crop will average 25 bushels or more per acre, while if it is planted after May 4 the chances of a normal crop or more is less than 50 percent.

The reason for this is found by reference to table 2. The time of tasseling of the corn crop was determined from the Weekly Weather and Crop Bulletin the same way that the date of planting had been, and was found to be about 70 days after the date of planting. Seventy days after planting, or May 4, is July 13, just 2 days after the period of the higher average of rainfall of July. If corn is planted after May 4 the tasseling period comes in the drier periods of the latter part of July. The correlation coefficient for the period July 12–21 was +0.51, the highest value of any of the 10-day periods. The coincidence of the high value of r for this period with the average date of tasseling indicates that the tasseling period is the most critical in the life of the corn plant.

The conclusions are:

(1) The tasseling period is the most critical period of the corn plant's life.

(2) The average date of tasseling in northeastern Kansas is July 14.

(3) Two and one-half inches, or more, of rain near the tasseling period practically insures a crop of 25 bushels per acre.

(4) The latter part of July is, on the average, drier than the earlier part.

(5) Corn planted before May 4 usually reaches the critical period of its life before the dry weather begins.

DIURNAL VARIATION IN THE DEW-POINT TEMPERATURE AT ASHEVILLE, N. C.

By LELAND T. PIERCE

[Weather Bureau office, Asheville, N. C., July 1934]

Dew-point temperature is a direct index of the amount of moisture in the air, and therefore is subject to a number of practical applications in the identification of air masses and in forecasting. It is of particular value in the prediction of minimum humidities, and in this role is especially important in the preparation of fire-weather forecasts such as are issued in this fire-weather district no. 8. Its value in this work has prompted the investigation of its diurnal variations, since a forecast of the minimum humidity for the day must be based upon its anticipated level at the time of the maximum temperature, as varying from the 8 a. m. figure.

The premise upon which forecasting of minimum humidity was initiated in this district assumes that there is little regular diurnal variation in the moisture content of the air, except as induced by changes in the air mass. However, it has been found by experience that dew points do change very materially throughout the day. It is plain, then, that if the diurnal variation both as to direction and amount can be allowed for under varying conditions, it will be possible to make more accurate forecasts of the minimum humidity. To determine this variation, it has been necessary to summarize a large amount of data, thereby balancing out changes incident to storm movement and local factors.

Progress in this work was beset with many difficulties other than the large amount of routine work involved. First, it was realized that a number of variables can and do have a definite effect upon the dew-point, such as air-mass changes, the effect of seasonal changes in transpiration from forest areas, and a multiplicity of local variants, most of which cannot be measured. The most disconcerting was lack of faith in the absolute accuracy of psychrometer readings. It is well known that the human element bulks large in determining the accuracy of psychrometer observations, as does the condition of the muslin on the wet bulb. Cases have been seen on this station when the dew-point figure has been lowered as much as 12 degrees simply by putting on a clean muslin. It is evident, too, that the errors due to personal inaccuracy and dirty wet bulbs are all in the same direction, and therefore are not self-compensating. However, fully realizing these inherent weaknesses of psychrometer readings, the work was necessarily conducted on the assumption that all original data are correct. Furthermore, it is believed that air masses, no matter how large, are by no means strictly homogeneous as regards moisture content. In consideration of these and other possible difficulties, records were taken for several years that extended over a period when observations were made consistently by the same two men.

It was assumed at the outset, and conclusions reached in this study verify the assumption, that cloudiness and wind direction, more than any other factors, have a bearing upon diurnal changes in the dew point. Therefore, dew points were classified according to occurrence on cloudy or on clear to partly cloudy days. This division into two classes only was made with the idea of keeping the routine work at a minimum, but it has since been concluded that a more detailed cloudiness classification should have been made. Figures were available, of course, for 8 a. m., local noon and 8 p. m. E. S. T., and in the tabulation the wind direction was included with each dew point, as was the prevailing direction for the day. The period of record covered was 1926 to 1932, inclusive. In order to suit the uses to which the data are to be put, noon and 8 p. m. dew points have been expressed in terms of departure from the 8 a. m. value. Emphasis has been placed upon the variations between morning and noon because this is the period of greatest importance in fire-weather forecasting. The first portion of this report deals with a recitation of facts concerning changes and trends, the explanation therefor being reserved for a later section.

TABLE 1.—*Average monthly departure local noon and 8 p. m. dew points from 8 a. m. values*

CLEAR TO PARTLY CLOUDY

Year	Time	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1932	Noon	−0.4	−2.6	−0.7	−2.1	−3.8	−1.5	−3.4	−4.3	−3.3	−2.0	−0.6	+6.4	−1.5
	8 p. m.	+2.0	−1.2	+2.1	+1.6	−0.7	+0.3	−0.7	+0.8	−0.1	+3.6	+1.4	+4.7	+1.1
1931	Noon	−0.3	−0.6	−0.3	−1.8	−0.4	−1.0	−0.9	−1.8	−0.6	−1.8	−0.1	+0.3	−0.7
	8 p. m.	+0.2	−0.7	+0.9	+0.4	−1.5	+0.8	+2.9	+1.4	+1.0	+0.2	+3.4	+2.0	+0.9
1930	Noon	+1.7	+0.5	−2.0	−1.3	−2.5	−2.5	−4.9	−4.2	+0.1	−1.0	−1.3	−1.9	−1.6
	8 p. m.	−1.4	+1.3	−0.6	0.0	−1.3	−0.5	−1.4	−0.6	+1.2	+0.9	−2.9	−1.6	−0.6
1929	Noon	+0.2	−0.4	−0.6	−4.2	−1.5	−2.3	−1.6	0.0	−0.9	−0.8	+0.4	+2.9	−0.7
	8 p. m.	+0.5	+2.0	+0.5	−2.2	+0.2	+0.8	+0.8	+1.2	+1.8	+1.8	+0.5	+4.5	+1.1
1928	Noon	+1.1	+0.5	−2.0	−2.9	−4.7	−1.6	−2.4	−0.6	−0.6	−0.4	−0.7	+1.5	−1.1
	8 p. m.	+3.5	+0.8	−1.0	−0.8	−1.8	−0.3	+0.5	+1.7	+3.8	+1.0	+0.7	+1.6	+0.8
1927	Noon	−1.8	−3.4	−2.6	−4.9	−2.7	−0.8	−2.9	−0.3	−0.9	−1.8	−0.2	−0.8	−1.8
	8 p. m.	−0.8	−0.8	+0.4	−1.0	+0.3	+2.7	+0.3	+2.5	+1.0	−0.1	+3.3	−1.5	+0.5
1926	Noon	−1.1	+0.2	−1.8	−1.6	−2.5	−3.1	−2.2	−1.6	+0.5	−0.8	−3.1	+1.3	−1.2
	8 p. m.	−0.5	+0.8	−0.3	−0.8	−0.6	−0.3	+0.5	+1.2	+1.5	+2.8	−2.4	+0.9	+2.7
Average	Noon	−0.09	−0.83	−1.43	−2.69	−2.59	−1.83	−2.61	−1.74	−0.81	−1.23	−0.80	+1.39	−1.23
	8 p. m.	+0.50	+0.49	+0.29	−0.40	−0.77	+0.50	+0.41	+1.17	+1.46	+1.46	+0.57	+1.51	+0.96
Percent cases		64	71	69	74	79	81	80	79	70	74	57	61	71.6

CLOUDY

Year	Time	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1932	Noon	+1.5	−0.9	+0.7	+1.0	−0.2	+2.0	−0.2	−1.7	−0.5	+2.2	+1.2	+1.1	+0.5
	8 p. m.	+4.1	+0.7	−0.1	+1.0	+3.2	+1.0	+1.4	+0.7	+1.4	+2.5	−1.4	+3.4	+1.4
1931	Noon	+3.8	+1.8	+1.5	+1.1	+2.9	−2.0	0.0	+0.4	0.0	+5.3	+1.2	+2.6	+1.5
	8 p. m.	+3.0	+4.2	+3.1	0.0	+1.9	+1.5	+9.7	0.0	−0.2	+6.6	+0.7	+4.1	+2.9
1930	Noon	+1.6	+5.5	+2.7	+3.0	+0.5	+0.3	+1.3	−1.0	0.0	0.0	+0.6	+1.9	+1.4
	8 p. m.	+2.5	+5.5	+3.2	+0.9	+3.2	+1.3	+2.8	−1.4	+1.0	+0.3	−1.3	+1.9	+1.6
1929	Noon	+5.1	+0.6	+1.4	−6.3	+2.3	−2.0	−2.0	+1.6	+1.1	+1.2	+0.3	+5.0	+0.8
	8 p. m.	+7.1	+2.7	+3.0	−6.0	+2.2	−0.2	+1.0	+1.6	+2.6	+1.1	+0.4	+4.0	+1.7
1928	Noon	+5.0	+1.7	−0.4	+0.5	+1.1	+1.4	−0.9	−0.6	−0.2	+1.8	0.0	+2.8	+1.1
	8 p. m.	+3.0	+4.7	+2.5	−0.3	+1.9	+1.9	+1.7	−0.9	−0.3	+4.2	+1.1	+3.8	+2.1
1927	Noon	+4.0	+2.1	+1.6	+1.4	−0.9	+1.0	−0.1	+0.6	−0.7	+1.6	+0.9	+4.3	+1.3
	8 p. m.	+2.0	+3.1	+2.7	+2.1	+1.4	+1.3	+1.9	+2.6	−1.0	−0.8	+0.2	+5.0	+1.7
1926	Noon	+2.5	−0.5	+1.6	−1.2	−2.0	−2.2	+0.2	+0.7	+0.9	+1.6	+3.4	+2.5	+0.6
	8 p. m.	+3.5	−5.8	+5.5	−0.7	−2.7	−2.4	+0.2	+1.0	+2.2	+1.0	+1.1	+3.8	+0.5
Average	Noon	+3.36	+1.47	+1.30	−0.07	+0.53	−0.19	−0.24	0.00	+0.09	+1.96	+1.09	+2.89	+1.03
	8 p. m.	+3.60	+2.16	+2.84	−0.43	+1.59	−0.63	+2.67	+0.51	+0.81	+2.13	+0.11	+3.71	+1.70
Percent cases		36	29	31	26	21	19	20	21	30	26	43	39	28.4

DIURNAL VARIATION IN DEW POINT

That there is a daily fluctuation in the dew point between a maximum during the night and a minimum in early afternoon, is shown by average figures presented in table 1, which are represented graphically in figure 1.

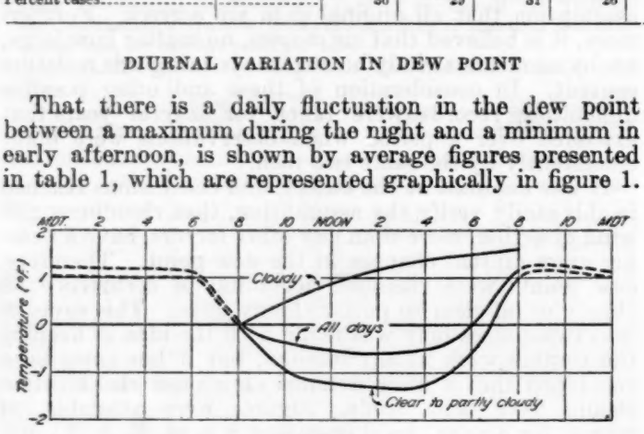


FIGURE 1.

The average annual departures for noon and 8 p. m. were used together with zero for 8 a. m. to fix the shape of the curve. It is obvious that each set of figures for individual months, given in table 1, could be used in drawing similar diurnal curves, but these, as is readily seen, would show an almost infinite variety of trends, for the reason that nonperiodic controls generally outweigh the diurnal tendency, and conditions vary from month to month.

Since data were available for the daytime only, the curves could be drawn with certainty only between 8 a. m. and 8 p. m., the extensions being based upon personal judgment in the light of processes involved. No attempt was made to complete the curve for cloudy days, since the data available did not indicate any natural cycle, though further research on the subject might disclose information for basing extensions of the line. This rising tendency for cloudy days, rather than representing a recurring diurnal cycle, merely expresses the fact that cloudiness in general precedes or accompanies precipitation, and therefore the portion shown is in reality just a section of a steadily rising curve.

TABLE 2.—*Variation of forenoon dew-point departures with wind direction and velocity*

Direction	Velocity					
	0-10 m. p. h.		11-20 m. p. h.		21 m. p. h. and over	
	Number of cases	Average departure	Number of cases	Average departure	Number of cases	Average departure
		°F.		°F.		°F.
N	48	+.31	58	−1.98	2	−5.00
NE	2	+.50				
E	8	−2.00	2	−3.50		
SE	76	+.86	74	+1.64		
S	99	+.90	55	+1.05	2	−8.00
SW	9	+1.10	3	−6.70		
W	13	−.61	5	−5.20		
NW	169	−.99	132	−2.80	15	−5.13

The deviation from the average curves which may be expected on a given day is, of course, very wide, since, as pointed out above, the immediate causes of change may completely obliterate the diurnal trend. It has been found that changes of air mass, with or without marked wind shift, are responsible for the widest dew-point changes. Irregularity in cloudiness through the day accounts for many other changes, but a number of wide departures occurred in original data, the reasons for which could be found only in unexplainable local causes.

Effect of wind direction and velocity upon forenoon dew-point changes.—Wind direction, as stated at the

outset, was considered one of the factors most likely to have a direct bearing on the tendency of the dew point. This was based on the simple fact that most rain-bearing winds are of southerly origin, while the drying winds blow from the northwest. A separate tabulation was made covering the 5-year period 1928 to 1932, including each day in the normal fire-season periods, February 15 to May 15, and October 15 to December 15. The results of this cross classification are presented in table 2. It is readily seen from this tabulation that wind direction does have a decided effect on the dew-point deviation during the forenoon. The application of these relationships to the diurnal dew-point variation will be further pointed out in the section dealing with physical explanations.

In practically all cases it is seen that plus departures accompany southerly winds, and minus northerly. Furthermore, this study brings out the fact that the amount of deviation varies also with the wind velocity. This might be expected, since winds of higher velocity are naturally more likely to bear air masses having characteristics peculiar to their respective directions. For instance, a weak LOW approaching this section will draw its air supply from regions to the southward, though for topographic or other local reasons the immediate wind direction in Asheville may be northerly. This northerly wind then, in a study of this sort, is classified with other north winds, even though it is really bearing an air mass of tropical rather than polar origin. This is a peculiarity often observed in Asheville, and it is undoubtedly the reason for the plus departure with light north winds shown in table 2.

Dew points computed from the temperature and humidity traces of a hygrothermograph at the Bent Creek Experimental Forest were plotted for a consecutive week in April 1933 to demonstrate the effect of wind direction upon dew-point levels, and to test the diurnal variations just determined. Bi-hourly wind directions and a record of cloudiness are presented along with the dew-point curve in figure 2. One rainy day was included in the period, and it is interesting to note the marked rise in dew point as the wind shifted into the southeast bringing cloudiness and rain, and the precipitous drop with the shift to northwest. Of particular interest, are the traces for the clear days, April 4, 7, and 10. This period was picked at random for cloudiness alone, but with the aid of horizontal lines drawn through the 8 a. m. value for the day, the diurnal tendency is plainly visible, even though it is somewhat distorted by other influences.

Effect of temperature level upon magnitude of variations.—Throughout the process of manipulating the daily figures, it was noticed that the level of the dew point had a decided effect on the magnitude of diurnal variations. During the winter and early spring the scattering of individual deviations varied much wider from the normal than during the warmer months. This may be a true effect of the temperature level itself, but it is probably induced largely by the natural differences in seasonal storm activity. The inherent tendency for unit errors in determining the wet-bulb temperature to result in greater errors in the dew-point computation at low temperature levels than at high, is another contributing cause of wider variations at low temperatures. Instructions have been issued at this station for wet-bulb muslins to be changed once each week, and for especial care to be taken in whirling the psychrometer, in order that recorded dew-point changes in all seasons and at all temperature levels can be accepted with confidence. Thus it will be possible, after a time, to check with certainty the effect of temperature level upon the variability of dew-point changes. At the present time (July 1934) daily variations are consistently small, and conform very faithfully to the average trend as shown in figure 1.

TABLE 3.—*Range in noon deviations from 8 a. m. dew points and percentage of cases falling between 5° plus and minus (1926)*

Temperature range	Range of deviation (degrees minus to degrees plus)	Percent of cases between −5° and +5° F.
20° and lower	8 to 18	50
20° to 40°	17 to 16	63
40° to 60°	22 to 9	71
60° and above	10 to 5	95

To get more accurate information concerning the limits of variability with different temperature levels, and the degree of faithfulness with which noon dew points approximated the 8 a. m. figure, a dot diagram was prepared from all data for the year 1926. The results are given in table 3, showing the range within which all noon dew points fell, and the percentage of all which fell within the limits 5 degrees plus and minus. In addition to this, the range of deviation was correlated with the level of the temperature during the winter and early spring months, when the seasonal effect could be eliminated, but little direct relationship was indicated. For this reason, it appears that the fidelity with which noon dew points approximate the 8 a. m. values is a result of characteristic seasonal changes.

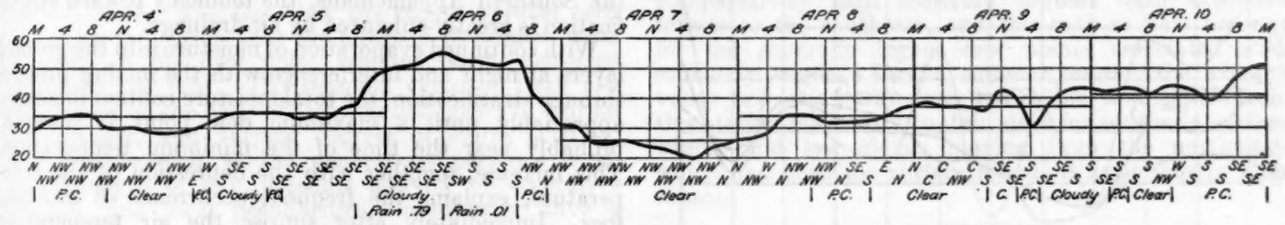


FIGURE 2.

SEASONAL VARIATION IN DEW POINT DEPARTURES

The noon and evening dew-point departures were arranged in table 1 according to months in order to bring out any seasonal tendencies which might prevail. The averages, then, were all plotted for the purpose of making the trend plainly visible. When considering these curves, it must be realized that they represent only the average monthly conditions, and that no attempt was made to eliminate the varying effects of seasonal changes in storm activity, precipitation, wind shifts or local variants. Indeed, it is the seasonal variation in the sum total of

these nonperiodic causative factors which introduces the element of seasonal change into the matter of diurnal dew-point departures.

On clear to partly cloudy days, as has been shown above, the dew point falls during the forenoon to an approximate minimum near noon. Now, the magnitude of

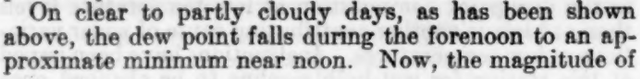


FIGURE 3.

this fall is seen in figure 3 to be greatest in the spring and summer months, and least in the colder seasons. The trend between noon and evening, on the contrary, is upward, reaching a point well above the morning figure by 8 p. m. The smallest positive departures, which actually amounted to a slight negative in April and May, occurred in the warmer season, while greatest positive values were recorded in fall and winter. On cloudy days the diurnal trend is definitely toward a constant rise throughout the daylight hours, but again the lowest positive departures are seen to be in the warmer months. Thus, the tendency, as shown by curves in both figures 3 and 4, is for an agreement in the seasonal variation in

FIGURE 4.

direction and magnitude of diurnal dew-point departures. This applies to all cloudiness and other weather conditions, and to both the noon and 8 p. m. departures.

Thus it is seen that all curves show a dip for the warmer and a rise to a maximum in the colder seasons. This tendency for the curves to parallel each other shows clearly that the seasonal variation of dew-point departures is quite independent of cloudiness or condition of the weather. Of much the same nature is the fact that the vertical distance between the curves is substantially the same at all times of year. This shows that the effect of cloudiness upon the diurnal trend of the dew point is practically constant throughout the year.

Of the four curves analyzed thus far, all but the one for evening departures on cloudy days are fairly smooth, and are homologous in shape. The remaining one is an exception to this rule, being very erratic, due to the relatively small number of cases represented. It is likely that with a longer period of record this curve would have smoothed out, as would the others to a more limited extent. Table 1 shows that only about 20 percent of the days in the period May to August were cloudy, these being the months showing the greatest irregularity.

The average trend of the dew point on all days, regardless of the cloudiness or other factors indicates a marked tendency for a fall until noon or shortly after, and a decided rise in late afternoon and evening, with the exception of the winter months. This is shown in figures 1, 3, and 4 by the median curve. Values on which these curves were based were obtained from the original data by weighting each monthly figure with the percentage frequency occurrence of the condition represented.

CAUSES OF DIURNAL VARIATION IN DEW-POINT TEMPERATURE

The moisture content of the air at a given station is constantly fluctuating for reasons which can ordinarily be read off a weather map. This applies to the irregular variations resulting from changes in air mass, precipitation, etc. However, it is more difficult to explain the diurnal variation. An extensive air mass gradually increases its moisture content as it passes overland by evaporation from the ground and vegetation, at rates dependent upon the temperature, relative humidity and available moisture. The total amount of moisture picked up in this way is greatest during the day when temperatures are highest and humidities lowest, but appreciable evaporation continues throughout the night. Furthermore, it is obvious that under ordinary circumstances, all this moisture must be absorbed by the lower layers, and transferred to higher levels by diffusion, turbulence and convection. During the day moisture taken on by the lower layers is rapidly diffused throughout the troposphere by constant mixing, but with decreased wind velocities and greatly diminished convection at night, the atmosphere tends to become stratified. In a mountainous section like the Southern Appalachians, the tendency toward stratification is greatly enhanced by air drainage.

With continued evaporation of moisture into the ground layers at night and interference with the mixing process through stratification, the total moisture content increases appreciably until a maximum dew point is reached, probably near the time of the minimum temperature. This increase, together with the depression of the temperature, explains the frequent occurrence of morning fogs. Immediately after sunrise the air temperature increases by heating from the ground, convection is initiated by the heated air, the stratified condition is destroyed, and soon there is active mixing of all layers of the troposphere. As soon as such mixing is accomplished, the excess moisture, accumulated in the lower layers, is rapidly transferred to higher levels, resulting in a diminution of the dew point near the ground. It is difficult to say just how rapidly the dew point is depressed, but considering the fact that convectional activity reaches its approximate maximum near 10 a. m. or 11 a. m., the early forenoon drop must be most rapid. There is likewise some uncertainty as to the exact time when the minimum value is reached, but it is probable that little further fall occurs after a thorough mixing has been accomplished between lower and intermediate layers, since the rate of evaporation increases steadily, greater and greater amounts of moisture being added to the surface air for transference to higher levels. This process, together with other factors of lesser importance,

accounts for the diminished dew points during the daytime.

The facts indicate that the dew point again rises during the late afternoon reaching a point substantially higher at 8 p. m. than 12 hours previous. The reason for this rise is probably the diminished wind velocity, with a resulting slower rate of moisture transference to higher levels. Simultaneously, the rate of surface evaporation, though diminishing, is still moderately high. The unexpectedly high evening dew points in Asheville are induced by the occurrence of a distinct valley breeze which operates throughout the year. The normal tendency toward a northwest wind during the day is reversed just after sunset, and a northwestward drift sets in bringing air from over the extensive forests to the southeast. Again, it is a matter to be settled by further research, whether the peak is reached in the early evening, or whether it increases constantly until the time of minimum temperature, but it appears reasonable that the peak should occur just before sunrise.

The foregoing discussion applies to clear or partly cloudy days. The trend is reversed for cloudy days. Two explanations may be offered. First, cloudy days are likely to be associated with the active portions of storms whose southerly winds have been shown to increase the dew point at a given station in their path. Secondly, the increased evaporation and transpiration during the day more than offset the loss of moisture by convection and turbulence, which are held to a low point by cloudiness and less active surface heating.

CAUSES OF SEASONAL VARIATION IN DEW-POINT DEPARTURES

It has been found that on clear and partly cloudy days, the depression of noon below morning dew points is greatest in the warmer months of the year; and that on cloudy days when a tendency obtains toward a daily rise, the smallest increases are found also in the warmer months. The two curves parallel each other with marked fidelity. It now remains to give an explanation of the observed facts. The fact that the curves parallel each other is an indication that the effect of cloudiness upon the trend of the dew point remains fairly well-fixed throughout the year. The seasonal variation itself can be explained on the basis of seasonal tendencies in diurnal wind changes, and varying degrees of storm activity. Other factors such as the general temperature level, varying length of day, seasonal activity of vegetative processes, and local peculiarities undoubtedly have a minor bearing, but the first two causes mentioned have the greatest effect.

Effect of seasonal variation in storm activity.—It has been pointed out that the principal cause for diurnal dew-point fluctuation is the cyclic change from night stratification to daytime turbulence in the atmosphere. Any factor which tends to interfere with this diurnal cycle will in turn tend to eliminate the daytime drop in the moisture content of surface layers. The winter season in these latitudes is marked by considerable storm activity, while in summer the passage of storms is much less frequent, and the atmosphere in general is characterized by comparative stability. Mixing of air layers is accomplished not only by thermal convection, but also by turbulence induced by horizontal winds. The higher the wind velocity, then, the more thorough the binding together of adjacent air layers, and the greater the rapidity with which moisture is transferred from the surface to higher levels. It is evident, then, that in winter, when storms are more intense, pass more frequently, and are accompanied by stronger winds, there is less opportunity for an excess of moisture to be stored in the surface air layers during the night. In the warm season, on the other hand, there is a maximum divergence between night stability and daytime convectional activity, the very conditions giving rise to large dew-point departures. Therefore, there is bound to be less difference between night and daytime dew points during the winter than in summer when nights are generally marked by surface inversions.

Effect of seasonal changes in diurnal wind variation.—Since wind direction has a good deal of influence on the level of the dew point, it seems logical that the diurnal direction variation might have a certain effect upon its daily trend. In this particular locality there is a definite diurnal shift in wind direction, part of which is due to valley and mountain breezes. The shift during all months of the year is toward the northwest by day, and the southeast by night. The cycle operates with considerable regularity during the warmer months, but for the remainder of the year, the southeasterly shift at night is confined to the early evening hours when the valley breeze is most active. If southerly winds tend to raise the dew point, it is evident that the difference between night and day figures should be greater in summer than in winter when the prevailing night wind direction is northwest instead of southeast. This explanation is not intended to convey the impression that a change in air mass accompanies the diurnal shift of wind. Indeed, this could not occur in every instance. Wind drift toward the northwest at night, however, does draw drainage air of comparatively high moisture content from extensive forests to the southeast, and this may in part account for the generally higher dew points associated with southerly winds. In the summer season, the evening valley breeze is particularly noticeable, and signals from this station frequently contain data for southerly surface winds, and low clouds moving from the northwest, which had been the surface direction until shortly after sunset.

CONCLUSION

The present study was prompted by a definite need for the information it affords, and which could not be found in any meteorological literature available at this station. It is not claimed that the results set forth are exact and complete, but the work has served to uncover the nature and approximate extent of diurnal dew point variations at this station. Further work along this line will be directed toward multiple correlation of dew point changes with various weather elements.

SOUTHEASTERLY WINDS OF THE SOUTHERN SAN JOAQUIN VALLEY, CALIF.

By LEON J. GUTHRIE

[Weather Bureau office, Bakersfield, Calif., July 1934]

The San Joaquin Valley embraces the southern section of the Great Valley of California. It is elongated on a northwest-southeast axis and terminates in a mountainous semicircle formed by the Sierra Nevada, Tehachapi and coast ranges. Because of prevailing westerlies and the valley contour, winds persist from the northwest with few exceptions throughout the year. Southeast winds represent an occasional interruption due to major disturbances of the atmosphere. Nocturnal breezes that spring up from northeast to southeast are not considered here.

Records for Bakersfield, which is situated near the foot of the San Joaquin Valley, show the following general characteristics for southeast winds: They average 6 hours in duration and attain an average maximum velocity of 27 miles per hour; the highest recorded was 44 miles per hour. Such a velocity is remarkable in view of the sheltered topography in this area. Southeasterlies here must blow down from the mountains. A low dust cloud near the foothills, 30 miles southeast of Bakersfield, signals the beginning of the wind. Gradually the dust cloud rolls northwestward up the valley in a broad stream. Tejon Field, at the point of onset, reports the highest velocities, the winds spreading out rapidly and losing velocity as they move up the valley. They start blowing usually in the forenoon and reach a maximum velocity in the early afternoon.

Because of the foehn nature of the above winds, temperatures rise rapidly during the day, except when heavy snow lies on the mountains. Snow retards the dynamic warming of air that moves down the slopes, as also does winter radiation if the wind occurs at night. Melting snow modifies the extreme dryness of the air. The average rise in temperature with southeast winds at Bakersfield was 32 degrees during the day, the extreme was 50 degrees. From a value of 81 percent in the early morning, relative humidity fell to 5 percent on one occasion. Such a marked change in temperature and relative humidity could come only from the displacement of the surface air by air from a considerable height. The southeast wind blows most frequently in the winter and spring, and is associated with general atmospheric disturbances. It is usually accompanied by a steady falling of the barometer.

Weather charts show that southeasters portend a shift from high- to low-pressure control for the San Joaquin Valley. They seem to originate from the following synoptic situations:

(1) A vigorous cyclone approaching the coast of California.

(2) High-pressure overflow from a stagnating anticyclone over the Great Basin.

(3) Local low pressure that forms in the Great Valley due to relatively higher temperatures or other reasons.

Of course the first two situations might interact and contribute about equally to produce a southeaster of unusual strength and duration. They are far from being mutually exclusive.

Rain often follows under the first condition, and occurs principally after the wind has shifted to the west. Being essentially storm winds, the number of storms in a season determines the number of southeast winds. As a storm approaches from the west or northwest, the winds gain in velocity until arrival of the cold front and rain. At the first impact of these dry southeasters, the lowering clouds of the storm may be dispersed or ceilings forced to a high elevation. But with the arriving wind-shift line, ceilings again drop, and rain begins. The intermixing of the dry southeast winds with the moist storm winds breaks up the continuity of the storm front, producing spotted and often light rainfall. Some weak storms may be entirely checked by the blowing of too much wind from the southeast. This would partly explain why the warm front of a storm brings little or no rain to this section of California. It is a common phenomenon to have storms lose their intensity as they move down the San Joaquin Valley. Fresno which is north of Bakersfield receives about 9.82 inches of rain a year, while Bakersfield receives 5.71 inches.

The second condition of high-pressure overflow might occur without any well defined LOW off the coast of California. When an anticyclone stagnates over the western plateau and builds up to its greatest intensity, it resembles a vast reservoir of air to be disposed of. The accumulated air mass is dammed by the Sierra Nevada, and a sharp gradient develops over these mountains as a consequence. To the west, in the San Joaquin Valley, pressure continues relatively low. Subsidence begins to take place, the air seeks lower levels and an outlet to the Great Valley or the ocean. Settling of the air might equalize gradients at high levels but it intensifies them below. This calls for movement of air over the lower ranges or through mountain passes by overflow. These winds reach high velocities in mountain passes sloping downward to lowland valleys or coastal plains. Anticyclonic air restricted by the high Sierra, overflows the lower reaches of these mountains where they join the Tehachapi Range, and the overflowing air is deflected downward to the valley floor.

In the lower San Joaquin Valley, the wind appears first at Tejon Field, which is located at the exact foot of the valley. From here it propagates northward, diminishing as the valley widens out before it. Ordinarily this true overflow does not travel much beyond Bakersfield. It varies much in respect to turbulence, judging by the heights to which dust is carried. With a southeast dust storm, dust was reported as high as 4,000 feet by pilots on March 6, 1931, but during most of these storms, only shallow dust clouds were stirred up. Despite some turbulence the air was stable in the beginning, otherwise it could not have flowed down into the valley. That the air is of high altitude origin is amply shown by its foehn characteristics—its extreme dryness and transparency. When the surrounding mountains stand out in fine relief, old residents believe that it is a sign of rain. This condition may be followed by low dust clouds at the foot of the valley, rolling to the north or west. Simultaneously, fresh to strong velocities reported at Tejon Field indicate that the southeast blow has come to the surface. Although the wind blows toward Bakersfield with as much as 40 miles per hour velocity, it may take 3 hours to cover the intervening distance to that city. This fact tends to show that the air stream spreads out and mixes by turbulence with the old valley air. Upon arrival at the more northerly station, velocities are usually diminished.

Some of the most violent of the continental overflows into the valley are caused by a stagnant Great Basin HIGH being wedged in between a cyclone lingering over the coast of southern California, and a companion or secondary cyclone over Arizona and New Mexico. In this case a high-pressure wedge extends down Nevada and the Sierra Mountains. Such a squeeze results in a forcing of air out of the HIGH with spilling of air down to the lower San Joaquin Valley. The wind pours through convenient mountain passes or over the crests of low ranges. At the same time, Los Angeles might experience a Santa Ana type of wind, blowing from the northeast down to the sea. High pressure overflow winds are evidenced at nearby mountain stations by strong northeasterlies and these same winds are in evidence at nearby coast stations, often to high altitudes. On one occasion the anticyclonic circulation was apparent over California even at the 10,000-, 12,000-, and 14,000-foot levels. These same winds are veered when reaching the San Joaquin Valley and blow from the southeast. As the barometer falls steadily with the blowing of the southeast winds, the anticyclone gradually expends itself and disappears, following which, in winter, a new air mass overlies the lower valley and the usual condition of valley ground fog may be forestalled for some period.

The third synoptic situation of low pressure developing locally in the Great Valley is attended by nearly the same phenomena as the approach of an ocean cyclone.

IS LOW RELATIVE HUMIDITY A GOOD INDICATION OF PRECIPITATION WITHIN THE NEXT 48 HOURS?

By A. R. LONG

[Weather Bureau office, Memphis, Tenn., September 1934]

(Abstract [1])

A tabulation of 7,305 observations of 8 a. m. (seventy-fifth meridian time) relative humidity at Memphis, Tenn., during 1907–26, inclusive, classified by wind direction and season, and compared with the occurrence of precipitation during the following 12-, 24-, 36-, and 48-hour periods, led to the following results (after the omission of cases with less than 10 observations):

In all seasons, when the 8 a. m. humidity is from 51 to 80 percent, the chances for precipitation within 36 hours or less are very small, and remain small even up to 48 hours; from 81 to 90 percent, the chances increase, but the highest probability is only 0.81 within 48 hours with an east wind; from 91 to 100 percent, the chances (which, of course, vary with wind direction) are considerably greater.

These results do not bear out the contention sometimes made that low humidity is a good indication of precipitation within the next day or two; on the contrary, low humidity appears to be a good indication that precipitation will *not* occur within 48 hours. As a rule, the *higher* the humidity, the greater the chances that precipitation will occur within 48 hours.

AN UNUSUAL SNOWSTORM IN SOUTHEASTERN WEST VIRGINIA

By W. J. HUMPHREYS

[Weather Bureau, Washington, September 1934]

The storm in question was that of February 26, 1934. The phenomena mentioned were described to me early in the following September by Mr. A. M. Eppling and others, of Gap Mills, W. Va. Here the snow fell until about 27 inches deep, and then changed to rain, followed by a freeze, that covered the whole with a sheet of ice 1 to 2 inches thick. A rare joy it was to boys with skates and sleds, but to stockmen a horror, for hundreds of sheep perished beneath it and neither cattle nor horses could cross it, even a short distance for feed or water, since at every step or attempted step the jagged edges of the broken crust cut their legs.

Then as the landscape lay bleak and imprisoned came mysterious sounds—muffled rumbles as of distant thunder or far-off blasting, owing, as finally found, to the sudden ripping of long rifts in the dense, thick glaze. Some of these were 2 inches wide, half a mile, or more, in length and quite straight.

Presumably it was a decrease in the temperature of the ice crust that caused it to become so strained that it finally broke; and a crack once started in this crust doubtless traveled with the high speed of the transverse elastic wave, producing as it went violent tremors and thereby a loud sound, muffled by the snow beneath, along its entire course. At any rate, owing to the damage done by this snow, the annoyance it caused, and the strange sounds it produced, the date of its occurrence is now one of the fixed points in the local chronology.

[1] The complete original manuscript is on file at the central office of the Weather Bureau, Washington, D. C.

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SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING AUGUST 1934

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments employed and their exposures, the reader is referred to the January 1932 REVIEW, page 26.

Table 1 shows that solar radiation intensities averaged above normal for August at Washington, close to normal at Madison, and below normal at Lincoln.

Table 2 shows an excess in the total solar and sky radiation received on a horizontal surface at New York, Fresno, Pittsburgh, and New Orleans, and a deficiency at all other stations for which normals have been computed.

Polar continental air masses were indicated on all days when turbidity measurements were made, as shown in table 3.

Polarization measurements obtained at Washington on 4 days give a mean of 58 percent with a maximum of 60 percent on the 27th. At Madison, measurements on 11 days give a mean of 47 percent with a maximum of 58 percent on the 28th. The values for Washington are above the August normals, while those for Madison are below normal.

TABLE 1.—*Solar radiation intensities during August 1934*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance										
	8a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e
	mm	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*mm*
Aug. 1	11.38				1.13	1.32					8.81
Aug. 6	7.57		0.77	0.93	1.16	1.39					7.87
Aug. 20	15.65			.74	1.03	1.38					10 21
Aug. 22	14.10	0.42	.54	.70							14.60
Aug. 27	12.68		.76	.94	1.14	1.45	1.18				8.48
Aug. 29	10.59		.76	.94	1.14	1.39					8.81
Aug. 30	6.76					1.38					6.27
Aug. 31	9.14			.79	.98	1.34					6.27
Means		(.42)	.69	.82	1.10	1.38	(1.18)				
Departures		−.21	±.00	+.05	+.16	+.14	+.15				

[1] Extrapolated.

MADISON, WIS.

Aug. 1	11.38		0.64	0.76	0.91	1.26					12.24
Aug. 2	19.23					1.29					14.10
Aug. 3	13.61		.54	.72	.88	1.25					13.13
Aug. 4	11.81		.59	.80	.98	1.19					13.61
Aug. 9	18.59					1.34					15.65
Aug. 13	16.79				.89	1.39					12.68
Aug. 18	16.20			.54	.78	1.21					15.11
Aug. 20	6.76					1.44					5.79
Aug. 21	9.14				.90						11.81
Aug. 22	9.14			.76	.99	1.30					8.81
Aug. 24	6.27			1.11	1.23	1.44					4.95
Aug. 25	5.56			1.07	1.22	1.45					6.27
Aug. 28	7.87			1.13	1.31	1.54	1.31				4.95
Aug. 29	7.57			1.06	1.20		1.13				6.50
Means			.59	.88	1.03	1.34	(1.22)				
Departures			−.23	−.05	−.06	+.02	+.13				

LINCOLN, NEBR.

Aug. 8	11.38			1.00	1.18	1.38	1.09	0.89	0.74	0.61	9.83
Aug. 17	18.59						.94	.70	.55	.46	18.39
Aug. 18	17.96		0.70	.78	1.06	1.27					14.60
Aug. 21	12.24						.86				11.38
Aug. 23	13.13			.70	.88	.99					12.24
Aug. 25	5.16	0.68	.78	.90	.98	1.30	.80	.60	.44	.34	5.56
Aug. 26	5.77	.79	.90	1.04	1.19	1.39					7.57
Aug. 27	8.18						1.17	1.01		.72	6.76
Aug. 28	7.57	.85	.96	1.10	1.27	1.47	1.24	1.04	.92	.76	6.02
Aug. 31	13.61	.57	.66								16.20
Means		.72	.80	.92	1.09	1.28	1.02	.85	.66	.58	
Departures		+.03	+.01	+.01	±.00	−.03	−.05	−.04	−.10	−.10	

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY

Aug. 1	13.6				0.83	1.16	0.94	0.68	0.54		11.8
Aug. 2	12.7				1.02	1.29					12.2
Aug. 3	18.6							.81	.67	0.59	15.1
Aug. 4	13.2					1.19					9.5
Aug. 5	10.6					1.35				.84	6.0
Aug. 6	7.6			1.09	1.22	1.37					8.5
Aug. 7	10.2					1.35					10.6
Aug. 8	13.6				.84	1.10	.84				13.1
Aug. 11	18.0							.86			12.7
Aug. 17	10.2				1.03	1.27	.98				10.6
Aug. 18	12.7					1.19					13.6
Aug. 21	6.3				1.19	1.44	1.20	1.04			6.0
Aug. 22	11.1				.91	1.17					11.9
Aug. 30	7.1				1.23	1.42	1.28				7.1
Aug. 31					1.05	1.00	.67				
Means				1.09	1.04	1.25	.98	.85	.60	.72	

TABLE 2.—*Average daily totals of solar radiation (direct + diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	Mount Washington	Friday Harbor
	Gram-calories per square centimeter															
	cal	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*
July 30	517	546	581	.....	503	703	477	370	600	578	436	370	600	541	.....	350
Aug. 6	294	367	479	.....	402	694	356	301	614	530	424	403	595	463	.....	589
Aug. 13	294	443	487	.....	300	647	393	252	576	562	478	433	535	444	.....	542
Aug. 20	410	466	415	.....	406	595	414	291	621	492	530	345	569	493	.....	562
Aug. 27	601	361	367	.....	461	594	468	218	522	462	457	376	534	464	.....	432
	Departures from weekly normals															
July 30	+50	+78	+69	.....	+92	+59	+9	+33	+14	(1)	−77	−25	.....	.....	.....	.....
Aug. 6	−144	−88	−12	.....	+39	+68	−37	+12	+19	.....	−80	+60	.....	.....	.....	.....
Aug. 13	+134	−2	+2	.....	−49	+42	−19	−42	−14	.....	+15	+97	.....	.....	.....	.....
Aug. 20	+1	+24	−66	.....	+95	+22	+51	−5	+49	.....	+35	+5	.....	.....	.....	.....
Aug. 27	+175	−45	−84	.....	+105	+44	+90	−35	−26	.....	−29	+13	.....	.....	.....	.....
	Accumulated departures on Sept. 2															
	+2,429	−2,163	+6,251	.....	+14,191	−7,945	−1,498	−896	+5,691	.....	−5,026	+7,847	.....	.....	.....	.....

1 New normals being prepared.

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during August 1934, and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated*

AMERICAN UNIVERSITY, WASHINGTON, D. C.

Date and hour angle	Solar altitude	Air mass	I_m	I_y	I_r	$\beta_{I_m-\gamma}$	$\beta_{I_y-\gamma}$	$\beta_{m=1.0}$	$\frac{I_{w=0}}{1.94}$ Percentage of solar constant	$\frac{I_{w=w}-I_m}{1.94}$ Percentage of solar constant	w	Air-mass type
Aug. 1, 1934	° ′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*						*mm*	
4:24 a	29 43	2.01	1.130	0.784	0.723	0.046	0.078	0.062	72.0	12.3	19	P_c
4:20 a	30 30	1.96	1.138	.785	.724	.046	.084	.065	71.2	11.0	11	
3:32 a	39 48	1.56	1.201	.821	.737	.044	.054	.049	78.1	14.4	44	
3:29 a	40 22	1.54	1.210	.932	.738	.042	.058	.050	78.3	14.1	41	
3:09 a	44 12	1.43	1.246	.929	.757	.042	.108	.075	75.4	9.6	6	
3:05 a	44 56	1.41	1.251	.930	.758	.042	.100	.071	76.0	9.9	8	
2:58 a	46 15	1.39	1.261	.976	.769	.046	.052	.049	79.6	13.0	32	
2:54 a	47 00	1.57	1.249	.975	.770	.052	.054	.053	79.0	13.0	33	
2:50 a	47 45	1.35	1.259	.974	.772	.052	.058	.055	79.5	13.0	35	
2:46 a	48 30	1.33	1.265	.975	.772	.048	.054	.051	80.4	13.6	38	
2:42 a	49 07	1.32	1.262	.988	.774	.048	.042	.045	80.9	14.2	44	
2:38 a	50 00	1.30	1.275	.988	.774	.046	.040	.043	81.6	14.3	45	
1:11 a	64 07	1.11	1.301	.978	.777	.048	.068	.058	82.2	13.5	45	
1:06 a	64 44	1.10	1.294	.977	.776	.050	.068	.059	82.2	13.8	46	
0:55 a	66 00	1.09	1.283	.971	.750	.046	.040	.043	83.9	15.1	50	
0:51 a	66 25	1.09	1.283	.971	.751	.048	.040	.044	83.9	16.1	50	
0:43 a	67 12	1.09	1.259	.939	.739	.054	.080	.067	81.6	15.0	50	
0:40 a	67 27	1.09	1.240	.939	.738	.070	.082	.076	79.8	13.3	50	
Aug. 6, 1934												
5:07 a	20 40	2.81	.957	.846	.710	.088	.078	.073	59.4	8.9	4	P_c
5:03 a	21 22	2.74	.978	.847	.711	.085	.082	.084	59.6	8.1	3	
4:59 a	22 08	2.64	.970	.864	.713	.082	.074	.078	62.4	10.2	5	
4:56 a	22 48	2.57	1.000	.865	.726	.086	.088	.087	65.0	12.4	16	
4:22 a	29 20	2.04	1.158	.969	.757	.048	.044	.046	74.2	13.2	28	
4:07 a	32 14	1.87	1.195	.970	.801	.063	.084	.076	69.8	6.9	3	
3:23 a	40 47	1.53	1.236	1.023	.855	.085	.079	.082	72.8	7.8	3	
3:20 a	41 18	1.51	1.245	1.025	.857	.080	.080	.080	73.6	8.1	4	
2:33 a	50 03	1.30	1.298	1.016	.827	.050	.064	.057	79.6	11.2	17	
2:30 a	50 36	1.29	1.323	1.014	.824	.042	.058	.050	80.8	11.2	18	
0:32 a	66 45	1.09	1.362	1.100	.902	.090	.100	.095	77.5	5.5	2	
Aug. 27, 1934												
3:15 a	38 00	1.62	1.218	1.000	.809	.078	.070	.074	73.2	10.0	9	P_c
3:12 a	38 33	1.60	1.218	1.003	.810	.078	.066	.072	73.8	10.6	10	
2:43 a	43 44	1.45	1.231	1.007	.814	.068	.078	.073	75.8	9.4	8	
2:39 a	44 25	1.43	1.296	1.020	.814	.052	.060	.056	78.8	11.6	17	
2:10 a	49 08	1.32	1.328	1.018	.822	.052	.078	.065	78.3	10.0	10	
2:06 a	49 51	1.32	1.346	1.021	.823	.038	.078	.058	79.2	9.5	8	
1:16 p	56 37	1.19	1.380	1.075	.865	.052	.070	.061	80.4	8.9	7	
1:20 p	56 07	1.20	1.360	1.075	.867	.065	.071	.068	79.8	9.3	7	
2:20 p	47 37	1.36	1.333	1.075	.799	.036	.048	.042	81.8	12.7	28	
2:25 p	46 46	1.38	1.343	1.014	.800	.032	.046	.039	82.1	12.5	25	
2:46 p	43 09	1.46	1.270	1.017	.817	.068	.066	.067	76.8	11.0	14	
2:50 p	42 39	1.48	1.259	1.019	.817	.072	.066	.069	76.4	10.1	10	
3:31 p	34 14	1.77	1.216	.978	.778	.048	.048	.048	78.2	13.1	30	
3:34 p	34 02	1.78	1.207	.978	.778	.054	.046	.050	76.2	13.6	32	
4:21 p	25 50	2.29	1.137	.886	.743	.042	.096	.069	67.6	8.6	4	
4:24 p	25 03	2.37	1.098	.886	.741	.060	.094	.077	64.8	7.8	3	
Aug. 30, 1934												
3:21 a	36 11	1.69	1.231	1.020	.830	.077	.069	.073	73.0	9.2	6	P_c
3:17 a	36 55	1.67	1.212	1.021	.831	.082	.066	.074	73.0	9.1	6	
1:43 a	52 14	1.26	1.326	1.077	.863	.080	.052	.066	79.0	10.3	12	
1:39 a	52 53	1.25	1.327	1.079	.865	.080	.052	.066	79.0	10.3	12	

Atmospheric conditions

Date	Temperature °C.	Wind, miles per hour	Direction	Visibility	Sky blueness	Polarization, percent	Clouds and remarks
Aug. 1	21	10	SW	12	4	54.6	Cumuli.
Aug. 6	20	12	NW	20	5	58.2	Do.
Aug. 27	19	9	NW	30	5	59.6	Light haze.
Aug. 30	16	10	NE	30	6	59.3	Light to moderate haze.

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during August 1934, and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated*—Continued

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY

Date and hour angle	Solar altitude	Air mass	I_m	I_y	I_r	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	$\frac{I_{w-r}}{1.94}$ (Percentage of solar constant)	$\frac{I_{w-r}-I_m}{1.94}$ (Percentage of solar constant)	w	Air-mass type
Aug. 1, 1934	° ′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*						*mm*	
3:00 a	45 04	1.41	0.930	0.710	0.575		0.177	0.177	62.4	13.0	35.6	Pc
0:53 a	63 31	1.11	1.104	.799	.642	0.181	.165	.173	68.5	9.9	13.0	
3:52 p	35 41	1.71	.937	.718	.590	.179	.152	.166	58.8	9.1	5.7	Pc
Aug. 2, 1934												
3:38 a	44 42	1.61	1.105	.806	.650	.110	.095	.102	69.1	10.5	11.0	NPc
2:30 a	49 51	1.30	1.198	.854	.679	.103	.095	.099	73.8	10.3	13.0	Tc aloft.
2:06 a	53 44	1.24	1.205	.862	.686	.103	.098	.100	74.6	10.6	15.0	
0:01 a	66 33	1.09	1.273	.884	.696	.090	.092	.091	78.1	10.5	18.0	
0:10 p	65 27	1.10	1.256	.869	.686	.094	.098	.096	77.5	10.8	20.0	
Aug. 4, 1934												NPc
2:29 a	58 28	1.18	1.121	.826	.662	.169	.134	.152	69.2	4.4	1.4	Tc aloft.
Aug. 6, 1934												
3:12 a	41 56	1.49	1.314	.915	.729	.046	.056	.051	78.8	9.1	6.3	Pc
3:08 a	42 39	1.48	1.310	.901	.711	.038	.047	.042	80.6	11.2	16.0	
Aug. 7, 1934												
2:48 a	45 17	1.40	1.238	.865	.680	.069	.062	.066	77.4	11.8	21.0	Pc
Aug. 8, 1934												
3:21 a	39 55	1.56	.959	.700	.555	.148	.110	.129	66.0	15.2	58.0	NPc.
3:13 a	40 48	1.53	.963	.704	.559	.150	.140	.145	64.3	13.3	33.0	
1:51 a	54 44	1.23	1.087	.774	.610	.140	.122	.131	71.0	13.3	41.0	
Aug. 11, 1934												
5:02 p	20 47	2.80	.895	.670	.532	.072	.065	.068	63.0	15.6	49.0	Pc
5:20 p	17 31	3.30	.882	.670	.535	.061	.052	.056	61.9	15.2	37.0	
Aug. 17, 1934												
3:10 a	40 00	1.55	1.146	.817	.660	.097	.104	.100	70.2	9.7	8.0	NPc
0:34 a	59 57	1.15	1.250	.890	.711	.081	.096	.088	77.2	11.2	22.0	
1:45 p	53 18	1.25	1.194	.849	.682	.121	.118	.120	72.5	9.4	8.7	NPc
4:27 p	26 07	2.27	.915	.670	.560	.108	.143	.126	57.2	8.8	4.1	
Aug. 18, 1934												
1:37 a	56 12	1.21	1.185	.850	.680	.130	.118	.124	72.3	9.7	10.0	NPc
0:30 p	60 10	1.15	1.115	.830	.682	.186	.132	.159	69.2	10.3	15.0	
Aug. 21, 1934												
2:20 a	47 14	1.36	1.340	.914	.732	.045	.075	.060	78.8	8.1	4.5	Pc
0:19 a	59 37	1.16	1.385	.954	.772	.067	.071	.069	79.9	6.9	3.4	
4:42 p	22 31	2.60	1.100	.808	.652	.048	.051	.050	68.6	10.6	8.6	NPc
Aug. 22, 1934												
2:40 a	43 51	1.44	1.024	.725	.603	.150	.200	.175	62.0	8.0	4.1	NPc
Aug. 30, 1934												
3:09 a	36 59	1.66	1.290	.929	.738	.055	.040	.048	77.5	9.7	7.5	Pc
2:51 a	39 58	1.59	1.323	.930	.738	.042	.045	.044	79.2	9.7	8.0	
1:55 a	48 17	1.33	1.358	.954	.753	.054	.041	.048	81.2	9.9	10.1	
3:59 p	28 16	2.10	1.353	.978	.775	.021	.034	.028	77.3	6.2	2.1	Pc
Aug. 31, 1934												
3:55 a	28 45	2.08	1.200	.886	.723	.066	.069	.068	79.5	16.5	60	Pc
3:10 a	36 34	1.67	1.170	.861	.711	.111	.112	.112	70.9	9.5	7.0	
1:07 p	56 23	1.19	.995	.739	.620							Pc
4:05 p	26 57	2.20	.582	.462	.416							

Atmospheric conditions during solar radiation measurements

Date and time from apparent noon	Air temperature	Wind (Beaufort scale)	Visibility	Sky blueness	Cloudiness and remarks
August 1934	°C.				
1; 3:00 a.	22.2	W 2	8	5	Few Ci, moderate hz.
1; 0:53 a.	25.0	WSW 2	8	5	1 Cu, moderate hz.
1; 3:52 p.	25.0	WNW 4	8	4	3 Cu, moderate haz.
2; 3:38 a.	23.9	ESE 4	8-9	6	Few Ci.
2; 2:30 a.	25.0	ESE 4	8-9	6	Few Ci.
2; 2:06 a.	25.0	ESE 4	8	6	
2; 0:01 a.	26.7	SxW 4	-------	------	1 Ci, Few Cu.
2; 0:10 p.	26.7	SxW 4	8	5	
4; 2:29 a.	21.7	NW 5	8	6	Few Ci, Few Cu, moderate hz.
6; 3:12 a.	15.0	NW 3	9	4	Few Ci few Frcu.
6; 3:08 a.	15.0	NW 3	9	5-6	1 Frcu.
7; 2:48 a.	19.4	SW 2	8	4	0 clouds.
8; 3:21 a.	20.6	SW 4	8	------	0 clouds.
8; 3:13 a.	20.6	SW 4	8	------	0 clouds.
8; 1:51 p.	26.1	S 5	8	------	1 Cu, moderate hz.
11; 5:02 p.	19.4	NExE 2	8+	6	1 Acu.
11; 5:20 p.	19.4	NExE 2	8+	6	1 Acu.
17; 3:10 a.	13.9	NxNE 2	7	6	Trace Frcu.
17; 0:34 a.	17.8	N 2	7	5	0 clouds.
17; 1:45 p.	20.0	NE 2	7	4	0 clouds.
17; 4:27 p.	23.2	SSE 2	7W, 8, 9E.	5	0 clouds.
18; 1:17 a.	21.7	SSW 8	8	1	3 Ci.
18; 0:30 p.	24.7	S 3	8	5	2 Ci, 2 Cu.
21; 2:20 a.	16.1	NW 2	9	6	1 Cist.
21; 0:19 a.	17.8	NWxN 2	9	6	2 Ci, 1 Acu.
21; 4:42 p.	22.2	SxW 2	8+	7	1 Ci, lt. hz.
22; 2:40 a.	19.4	SW 4	8	4	1 Acu, few Frcu; fumules over sky.
30; 3:09 a.	11.9	NW 3	8	6	Few Cu.
30; 2:51 a.	13.1	NW 5	9	6	3 Cu.
30; 1:55 a.	13.3	NW 5	9	6	3 Cu.
30; 3:59 p.	16.9	NW 5	9	8	4 Cu
31; 3:55 a.	10.6	N 3	8	6	1 Ci in E.
31; 3:10 a.	11.0	N 3	8	6	1 Ci in E.
31; 0:07 p.	17.5	NNE 3	9+	1	10 Ci haze; trace Cu.
31; 4:05 p.	17.2	NNE 2	9	4	4 to 9 Ci, ill defined; hz. in N.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy, Superintendent U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time	Heliographic			Area		Total area for each day	Observatory
		Diff. in longitude	Longitude	Latitude	Spot	Group		
1934	h m	°	°	°				
Aug. 1	11 50	(1)	(1)	(1)				U. S. Naval.
Aug. 2		(1)	(1)	(1)				Harvard.
Aug. 3	11 53	(1)	(1)	(1)				U. S. Naval.
Aug. 4	11 21	(1)	(1)	(1)				Do.
Aug. 5	13 52	(1)	(1)	(1)				Do.
Aug. 6	11 8	−75.0	229.1	−30.0	154		154	Do.
Aug. 7	13 17	−61.0	228.7	−30.0	185		185	Do.
Aug. 8	13 54	−49.0	227.1	−30.0	201		201	Do.
Aug. 9	10 4	−36.9	228.1	−30.0	335		335	Harvard.
Aug. 10	13 10	−23.0	227.1	−30.0	201		201	U. S. Naval.
Aug. 11	12 0	−12.0	225.5	−29.0	303		303	Mount Wilson.
Aug. 13	12 50	−15.0	195.6	+4.0		15		Do.
		+14.0	224.6	−29.0	159		174	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Heliographic			Area		Total area for each day	Observatory
		Diff. in longitude	Longitude	Latitude	Spot	Group		
1934	h m		°					
Aug. 14	11 1	−2.5	195.9	+4.0		31		U. S. Naval.
		+27.0	225.4	−30.0	216		247	
Aug. 15	11 3	+11.5	196.6	+4.0	185			Do.
		+39.5	224.6	−30.0		46	231	
Aug. 16	13 50	+26.0	196.4	+4.0		36		Mount Wilson.
		+55.0	225.4	−29.0	160		196	
Aug. 17	13 27	+39.0	196.4	+3.5	15			U. S. Naval.
		+66.0	223.4	−30.0	123		138	
Aug. 18	12 0	+19.0	163.9	−23.0		7		Mount Wilson.
		+52.0	196.9	+4.0	3			
		+80.0	224.9	−29.0	157		167	
Aug. 19	12 46	(1)	(1)	(1)				U. S. Naval.
Aug. 20	13 27	(1)	(1)	(1)				Do.
Aug. 21	13 14	(1)	(1)	(1)				Do.
Aug. 22	13 17	(1)	(1)	(1)				Do.
Aug. 23	13 26	(1)	(1)	(1)				Do.
Aug. 24	13 15	(1)	(1)	(1)				Do.
Aug. 25	11 47	(1)	(1)	(1)				Do.
Aug. 26	9 0	(1)	(1)	(1)				Mount Wilson.
Aug. 27	11 15	(1)	(1)	(1)				U. S. Naval.
Aug. 28	14 23	(1)	(1)	(1)				Do.
Aug. 29	11 31	(1)	(1)	(1)				Do.
Aug. 30	10 57	(1)	(1)	(1)				Do.
Aug. 31	13 20	(1)	(1)	(1)				Do.

[1] No spots.

NOTE.—Mean daily area for 30 days: 84.

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR AUGUST 1934

(Dependent alone on observations at Zurich and its station at Arosa)

Data furnished through the courtesy of Prof. W. Brunner, Eidgenossische Sternwarte, Zurich, Switzerland]

August 1934	Relative numbers	August 1934	Relative numbers	August 1934	Relative numbers
1	0	11	12	21	0
2	0	12	Eae 21	22	0
3	0	13	21	23	7
4	-------	14	23	24	8
5	0	15	24	25	0
6	d8	16	26	26	0
7	8	17	17	27	-------
8	9	18	22	28	0
9	10	19	13	29	0?
10	11	20	0	30	7
				31	0?

Mean for 29 days=8.5.

a=Passage of an average-sized group through the central meridian.
b=Passage of a large group or spot through the central meridian.
c=New formation of a center of activity: E, on the eastern part of the sun's disk; W, on the western part; M, in the central zone.
d=Entrance of a large or average-sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. Little, in charge]

By L. T. SAMUELS

Mean free-air temperatures and relative humidities for August are shown in table 1. From the few departures available, it is seen that temperatures averaged considerably above normal in the central part of the country. Free-air temperatures over the western plateau averaged higher than over adjacent low-lying regions up to at least 5,000 meters. Free-air relative humidities averaged lowest over the middle Pacific coast and highest over the southeastern part of the country.

Resultant free-air winds for the month contained a preponderance of southerly components over the southern part of the country. Elsewhere the resultant directions were close to normal. The largest deviations from the normal resultant free-air velocities occurred in the north central and northeastern sections of the country where they were greatly in excess of the normals.

TABLE 1.—*Free-air temperatures and relative humidities obtained by airplanes during August 1934*

Station	Altitude (meters) m.s.l.															
	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
TEMPERATURE (°C.)																		
Billings, Mont.[1] (1090 m)	16.8						19.9		17.5		13.8		9.8		1.3		−7.2	
Cheyenne, Wyo.[1] (1873 m)	14.3								15.7		17.1		14.4		6.8		−1.7	
Fargo, N. Dak.[1] (274 m)	13.9		16.5		16.6		14.3		11.4		8.6		5.6		−0.2		−6.5	
Fort Crockett (Galveston), Tex.[2 3] (3 m)	27.0		25.4		22.9		20.6		18.0		15.1		12.2		6.1		−1.3	
Kelly Field (San Antonio), Tex.[2] (211 m)	24.2		23.8		22.1		20.4		17.5		14.7		11.8		5.7		−0.8	
Maxwell Field (Montgomery), Ala.[2] (52 m)	23.8		24.5		22.5		19.5		16.7		13.8		10.9		5.2		−0.5	
Mitchell Field (Hempstead, L. I.), N. Y.[2] (39 m)	17.3		18.9		16.4		14.0		11.2		8.7		6.2		0.6		−5.7	
Murfreesboro, Tenn.[1] (174 m)	22.1		23.1		21.9		19.1		16.6		13.3		10.4		3.8		−2.4	
Norfolk, Va.[4] (3 m)	23.0	−1.2	22.4	−0.6	20.3	−0.5	17.2	−0.4	14.2	−0.2	11.7	0.0	9.2	+0.2	4.3	+0.2	−1.0	+0.2
Oklahoma City, Okla.[1] (391 m)	25.3		26.1		25.8		22.6		19.0		15.7		12.4		5.6		−0.8	
Omaha, Nebr.[1] (300 m)	19.5	(6)	21.9	(6)	23.4	+3.1	21.4	+3.6	15.6	+3.8	15.3	+3.7	11.7	+3.5	4.5	+2.9	−2.2	+2.3
Pearl Harbor, Territory of Hawaii (5 m)	24.1	−4.3	22.0	−1.0	18.2	−0.5	15.3	−0.7	13.7	+0.2	11.5	+0.4	8.7	−0.2	2.7	−4.8	−2.6	
San Diego, Calif.[4] (10 m)	18.8	−2.4	16.8	−2.3	22.2	−0.8	22.8	+0.5	20.1	−0.5	16.7	−0.5	13.2	−0.6	6.6	−0.5	0.5	−0.5
Scott Field (Belleville), Ill.[2] (135 m)	20.3		24.0		22.6		19.8		17.0		13.6		9.8		2.5		−4.3	
Seattle, Wash.[4] (8 m)																		
Selfridge Field (Mount Clemens), Mich.[2] (177 m)	16.4		19.0		16.9		14.3		11.5		9.2		6.7		1.7		−4.6	
Spokane, Wash.[4] (596 m)	14.5				20.9		18.1		13.9		9.4		5.4		−1.0		−7.7	
Sunnyvale, Calif.[3] (6 m)	15.8		13.3		18.2		22.1		20.4		17.5		13.8		5.1			
Washington, D. C.[3] (2 m)																		
Wright Field (Dayton), Ohio[3] (244 m)	17.8		19.8		19.5		16.7		14.0		11.4		8.6		2.7		−3.5	
RELATIVE HUMIDITY (PERCENT)																		
Billings, Mont.[1] (1,090 m)	50						36		34		36		40		48		56	
Cheyenne, Wyo.[1] (1,873 m)	66								61		49		46		47		53	
Fargo, N. Dak.[1] (274 m)	78		63		55		51		51		50		48		46		44	
Fort Crockett (Galveston), Tex.[2 3] (3 m)	84		83		64		53		50		49		47		49		59	
Kelly Field (San Antonio), Tex.[2] (211 m)	90		92		79		62		61		58		55		53		59	
Maxwell Field (Montgomery), Ala.[2] (52 m)	93		75		70		71		69		67		67		61		62	
Mitchel Field (Hempstead, L. I.), N. Y.[2] (39 m)	90		69		66		64		61		53		48		40		38	
Murfreesboro, Tenn.[1] (174 m)	90		77		73		74		68		68		64		64		58	
Norfolk, Va.[4] (3 m)	86	+7	77	+7	72	+7	73	+8	76	+10	72	+8	66	+6	50	+6	43	+6
Oklahoma City, Okla.[1] (391 m)	65		59		51		52		53		55		56		52		56	
Omaha, Nebr.[1] (300 m)	72	(6)	62	(6)	48	−12	46	−12	46	−12	48	−9	51	−6	58	+6	58	+5
Pearl Harbor, Hawaii[4] (5 m)	84	+22	82	+9	86	+4	79	+1	63	−7	49	−10	44	−4	45	+35	41	
San Diego, Calif.[4] (10 m)	85	+8	90	+12	48	+6	35	+2	39	+8	45	+12	51	+16	56	+18	54	+18
Scott Field (Belleville), Ill.[2] (135 m)	91		64		62		61		56		49		49		49		48	
Seattle, Wash.[4] (8 m)																		
Selfridge Field (Mount Clemens), Mich.[2] (177 m)	83		62		57		54		53		48		44		39		35	
Spokane, Wash.[4] (596 m)	58				37		35		36		40		42		38		34	
Sunnyvale, Calif.[4] (6 m)	80		88		60		34		25		20		18		18			
Washington, D. C.[4] (2 m)																		
Wright Field (Dayton), Ohio[3] (244 m)	86		71		62		63		59		55		53		47		41	

Observations taken at 5 a. m., 75th meridian time, except along the Pacific coast and Hawaii, where they are taken at 5 a. m. local standard time.

[1] Weather Bureau.
[2] Army.
[3] June to November, inclusive, only.
[4] Navy.
[5] National Guard.
[6] Surface and 500-meter level departures omitted because of difference in time of day between airplane observations and those of kites upon which the normals are based.

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 7 a. m. (E. S. T.) during August 1934*

[Wind from N=360°, E=90°, etc.]

Altitude (m) m. s. l.	Albuquerque, N. Mex. (1,554 m)		Atlanta, Ga. (309 m)		Bismark, N. Dak. (518 m)		Brownsville, Tex. (7 m)		Burlington, Vt. (132 m)		Cheyenne, Wyo. (1,873 m)		Chicago, Ill. (192 m)		Cleveland, Ohio (245 m)		Dallas, Tex. (154 m)		Havre, Mont. (762 m)		Jacksonville, Fla. (14 m)		Key West, Fla. (11 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	356	1.4	292	0.7	69	1.2	150	1.5	188	1.9	295	2.6	86	0.1	177	1.3	184	3.0	47	0.7	200	0.6	107	2.7
500	------	------	282	2.2	------	------	168	8.9	226	4.2	------	------	3	0.8	223	2.1	210	9.0	------	------	213	4.3	109	5.4
1,000	------	------	269	3.2	202	2.5	167	8.8	279	4.7	------	------	300	1.9	283	2.5	208	9.0	270	0.1	214	3.6	117	6.0
1,500	------	------	275	3.8	271	4.0	162	7.8	288	7.0	------	------	281	4.7	288	5.4	195	6.2	278	2.6	205	2.5	119	4.9
2,000	57	1.1	275	3.6	292	6.0	158	5.6	283	8.6	292	3.5	284	6.6	280	7.1	181	4.4	286	4.5	180	1.8	110	4.2
2,500	201	0.7	284	3.7	296	7.9	139	3.9	288	9.0	278	2.8	292	10.2	279	8.3	164	3.5	294	5.2	177	1.8	110	3.7
3,000	238	1.4	277	2.8	295	9.1	114	3.3	262	10.3	262	4.2	283	12.6	282	11.0	149	3.5	285	7.0	166	2.0	115	2.8
4,000	190	1.9	263	2.5	288	10.1	80	3.4	280	8.0	272	6.5	291	18.3	277	11.5	133	2.4	278	8.6	156	1.8	175	1.1
5,000	158	3.3	238	0.8	287	10.0	79	4.4	------	------	268	6.6	------	------	286	10.0	74	1.8	290	9.1	48	0.6	231	4.1

Altitude (m) m. s. l.	Los Angeles, Calif. (217 m)		Medford, Oreg. (410 m)		Memphis, Tenn. (83 m)		New Orleans, La. (19 m)		Oakland, Calif. (8 m)		Oklahoma City, Okla. (402 m)		Omaha, Nebr. (306 m)		Phoenix, Ariz. (338 m)		Salt Lake City, Utah (1,294 m)		Sault Ste. Marie, Mich. (198 m)		Seattle, Wash. (14 m)		Washington, D. C. (10 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	111	0.7	199	0.6	182	1.7	198	0.6	263	1.2	181	4.1	100	0.9	104	1.7	151	3.5	18	0.3	139	0.7	313	0.5
500	111	1.1	254	0.9	242	7.8	234	2.9	250	1.9	194	7.5	144	2.2	138	1.4	------	------	287	1.5	11	1.6	307	2.3
1,000	63	0.3	287	1.4	254	7.9	191	3.3	327	3.7	217	13.3	213	4.4	215	0.8	------	------	279	4.4	351	2.6	295	3.5
1,500	313	2.1	54	0.8	260	6.2	172	3.2	313	3.3	221	7.7	259	5.7	276	1.6	153	4.8	290	5.3	342	2.5	295	5.1
2,000	280	2.4	137	0.6	273	3.7	156	3.8	274	3.2	216	3.9	268	6.3	286	1.5	180	3.3	294	7.2	297	1.8	292	7.2
2,500	217	2.7	219	3.6	262	2.6	121	3.0	276	4.7	202	1.9	276	7.3	298	1.2	209	2.5	294	9.0	264	2.2	288	8.4
3,000	160	3.5	216	5.0	219	1.0	94	3.2	------	------	147	1.2	283	9.0	158	0.4	246	2.8	298	10.0	261	3.5	281	10.1
4,000	140	4.4	222	7.1	46	1.3	74	3.7	------	------	114	2.3	266	9.1	150	3.6	265	4.8	295	10.6	262	6.1	278	10.8
5,000	122	2.5	240	8.9	------	------	59	2.8	------	------	------	------	------	------	131	4.5	269	7.6	------	------	269	8.9	------	------

RIVERS AND FLOODS

By RICHMOND T. ZOCH

[River and Flood Division, Montrose W. Hayes, in charge]

The floods which occurred at gage stations, on rivers where flood service is maintained by the Weather Bureau, were of minor consequence, as shown in the accompanying table of flood stages. However, more noteworthy floods occurred on several small streams where no flood service is maintained, as follows:

Heavy rains fell in portions of northeastern Kentucky and adjoining portions of West Virginia on August 10, and caused the creeks there to overflow. Damage to the extent of $250,000 and the loss of two lives resulted from these overflows.

Three floods occurred in Colorado, viz, in the Bear Creek Canyon, in the Mount Vernon Canyon, and in small streams near South Fork, Colo., causing the loss of six lives and more than $50,000 damage.

There were 3 floods in Arizona, 1 near Duncan, Ariz., 1 at Miami, Ariz., and another near Wickenburg, Ariz. The total damage was about $12,000. The flood near Duncan drove more than 25 families from their homes, and the one near Wickenburg caused the loss of one life.

Most rivers in the United States were very low. Many low-water records were broken; a table of previous records that were exceeded in either July or August 1934 is herewith.

Besides the stations which broke their all-time low-water records, Sioux City (Iowa), Boonville, Hermann and St. Charles (Mo.), on the Missouri River, and Dubuque (Iowa), Hannibal and St. Louis (Mo.), and Grafton, Alton, and Chester (Ill.), on the Mississippi River, had lower stages than had previously been recorded in the month of August. Cairo, Ill., on the Ohio River, had the lowest August stage since 1894.

Table of flood stages in August 1934

[All dates in August unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE					
Tar:	*Feet*			*Feet*	
Rocky Mount, N. C.	9	27	27	10.0	27
Greenville, N. C.	14	30	Sept. 1	14.8	31
Santee: Rimini, S. C.	12	9	10	12.3	9
		17	17	12.4	17
		22	25	12.7	24
		30	31	13.6	31
MISSISSIPPI SYSTEM					
Ohio Basin					
Gauley: Summersville, W. Va.	10	17	17	11.0	17
Arkansas Basin					
North Canadian: Yukon, Okla.	7	27	28	8.4	28

Table of lowest stages in July and August 1934

River and station	Length of record	Previous lowest	Date	July 1934 lowest	Date	August 1934 lowest	Date
ST. LAWRENCE DRAINAGE							
	Years	*Feet*		*Feet*		*Feet*	
St. Marys: Fort Wayne, Ind.	3	0.9	June 19, 1931	.6	25	0.4	5
St. Joseph: Fort Wayne, Ind.	3	4.5	Aug. 26, 1932	4.4	15	----	----
ATLANTIC SLOPE DRAINAGE							
Lackawaxen: Hawley, Pa.	26	.3	Sept. 3, 1929	.1	12	----	----
Shenandoah: Riverton, Va.	26	.2	July 26, 1932	.1	24	----	----
MISSISSIPPI SYSTEM							
Upper Mississippi Basin							
Minnesota: Mankato, Minn.	30	1.9	Nov. 14, 1933	----	----	1.7	3
Raccoon: Van Meter, Iowa	19	1.5	June 28, 1933	----	----	1.4	9
Des Moines: Tracy, Iowa	14	2.2	Mar. 10, 1931	----	----	2.0	27
Bourbeuse: Union, Mo.	18	.6	Aug. 12, 1933	.4	23	.4	1
Meramec: Valley Park, Mo.	18	.5	Aug. 27, 1933	.1	17	.0	10
Mississippi:							
Red Wing, Minn.	40	−2.5	Oct. 14, 1933	----	----	−3.5	28
La Crosse, Wis.	59	−2.2	Aug. 29, 1933	----	----	−2.4	29
Lansing, Iowa	22	−.8	Aug. 31, 1933	----	----	−1.24	30
Prairie du Chien, Wis.	55	−.5	Nov. 18, 1933	----	----	−.9	29
Clinton, Iowa	30	−.5	Dec. 22, 1933	----	----	−1.0	31
Keithsburg, Ill.	3	−1.4	Dec. 16, 1933	----	----	−1.6	31
Missouri Basin							
Republican: Concordia, Kans.	4	1.1	Oct. 5, 1932	.5	31	.2	20
Kansas:							
Wamego, Kans.	19	1.5	Feb. 22, 1918	----	----	1.2	18
Topeka, Kans.	30	1.7	Oct. 12, 1922	----	----	1.4	31
Grand: Gallatin, Mo.	9	1.7	July 20, 1926	1.5	21	1.3	10
Ohio Basin							
West Fork: Weston, W. Va.	31	−.4	Oct. 7, 1933	−.6	10	----	----
Tuscarawas: Newcomerstown, Ohio.	6	−1.0	Oct. 16, 1933	−1.2	29	−1.2	1
Mad: Springfield, Ohio	20	1.6	Aug. 22, 1924	1.4	29	1.4	1
Whitewater: Brookville, Ind.	16	0.9	Sept. 11, 1933	0.3	26	----	----
Miami:							
Piqua, Ohio	23	1.0	Aug. 26, 1933	0.8	17	0.8	1
Tippecanoe City, Ohio	11	−1.4	Aug. 23, 1932	−1.5	31	----	----
Franklin, Ohio	11	0.2	Sept. 6, 1925	0.0	26	0.0	8
Wabash:							
Bluffton, Ind.	23	0.7	June 23, 1913	0.2	26	0.2	4
La Fayette, Ind.	20	0.8	Jan. 14, 1931	0.6	28	0.6	1
Vincennes, Ind.	17	−0.2	Jan. 23, 1931	−0.8	1	----	----
Black: Leeper, Mo.	13	1.7	Aug. 29, 1933	1.3	20	1.2	10

Table of lowest stages in July and August 1934—Continued

River and station	Length of record	Previous lowest	Date	July 1934 lowest	Date	August 1934 lowest	Date
MISSISSIPPI SYSTEM—continued							
White Basin	*Years*	*Feet*		*Feet*		*Feet*	
White:							
Calico Rock, Ark.	30	−1.2	Sept. 3, 1913	----	----	−1.5	9
Batesville, Ark.	30	3.6	Sept. 14, 1932	3.5	24	----	----
Newport, Ark.	44	−0.3	Oct. 2, 1901	−0.4	24	−0.8	11
Arkansas Basin							
Verdigris: Sageeyah, Okla.	6	2.9	Sept. 10, 1932	2.8	20	2.4	19
Neosho:							
LeRoy, Kans.	25	−0.8	Aug. 8, 1918	----	----	−1.0	28
Fort Gibson, Okla.	30	5.0	Oct. 7, 1931	4.4	29	4.0	16
North Canadian: Woodward, Okla.	15	−0.6	Sept. 8, 1931	−0.8	24	−1.0	10
Arkansas:							
Wichita, Kans.	35	0.5	Aug. 12, 1933	0.4	27	0.4	1
Ralston, Okla.	12	0.6	July 10, 1933	0.3	29	0.1	19
Tulsa, Okla.	30	−0.6	Sept. 23, 1931	−0.7	27	−0.7	15
Ozark, Ark.	7	−1.9	Sept. 27, 1931	----	----	−2.3	21
Morrilton, Ark.	7	−3.0	Dec. 23, 1932	−3.2	30	−3.8	15
Little Rock, Ark.	55	−2.9	Oct. 1, 1931	−3.6	31	−4.2	22
Pine Bluff, Ark.	28	0.7	Sept. 13, 1925	----	----	0.3	24
Red Basin							
Ouachita: Arkadelphia, Ark.	21	−1.4	Nov. 9, 1931	−1.6	29	−1.8	21
Red: Denison, Tex.	28	0.8	Sept. 2, 1929	----	----	0.5	21
Lower Mississippi Basin							
Big Lake Outlet: Manila, Ark.	3	2.4	Sept. 17, 1932	----	----	2.3	11
St. Francis:							
Fisk, Mo.	11	1.6	July 23, 1932	1.3	23	1.3	2
St. Francis, Ark.	20	2.8	Nov. 11, 1931	----	----	2.6	9
WEST GULF OF MEXICO DRAINAGE							
Sabine: Logansport, La.	31	−1.2	Oct. 25, 1910	----	----	−1.3	22
Neches: Rockland, Tex.	31	.8	Oct. 20, 1904	----	----	−.9	9
Colorado: Marble Falls, Tex.	26	−1.7	Sept. 30, 1931	----	----	−2.3	24
Rio Grande: Riogrande, Tex.	22	1.7	Apr. 18, 1932	1.4	7	1.4	30
GULF OF CALIFORNIA DRAINAGE							
Green: Green River, Wyo.	19	1.0	July 19, 1931	.9	20	----	----
San Juan: Farmington, N. Mex.	22	−1.0	July 31, 1918	−1.8	4	----	----
PACIFIC SLOPE DRAINAGE							
Columbia Basin							
Middle Fork: Eula, Oreg.	11	1.2	Sept. 4, 1931	----	----	1.1	27
Willamette: Salem, Oreg.	39	−3.7	Sept. 5, 1931	----	----	−3.9	25

WEATHER OF THE ATLANTIC AND PACIFIC OCEANS, AUGUST 1934

[The Marine Division, W. F. McDonald, in charge]

NORTH ATLANTIC OCEAN

By H. C. HUNTER

Atmospheric pressure.—The pressure averaged less than normal over most of the ocean north of the fiftieth parallel of latitude; the station at Reykjavik, Iceland, computed almost one-fifth of an inch less than normal. From the fiftieth parallel southward, there was nearly everywhere a slight excess.

During the last days of August, comparatively high pressure prevailed over much of the North Atlantic and adjacent land areas. The highest reading yet received was noted on the forenoon of the 31st, when the Dutch motorship *Rotterdam*, near latitude 38° N., longitude 37° W., recorded 30.56 inches. The lowest reading during the month, 28.76 inches, was made on the American steamship *Capulin*, at 3 a. m. of the 18th, near 58° N., 28° W.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, August 1934*

Stations	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.76	----	29.93	23, 24	29.49	7
Reykjavik, Iceland	29.63	−0.18	29.96	7	29.06	28
Lerwick, Shetland Islands	29.69	−.11	30.11	26	29.26	22
Valencia, Ireland	29.88	−.04	30.17	14	29.51	28
Lisbon, Portugal	30.06	+.04	30.23	31	29.90	15, 16
Madeira	30.09	+.06	30.16	19	30.01	16
Horta, Azores	30.26	+.06	30.46	31	30.06	22
Belle Isle, Newfoundland	29.84	−.05	30.24	29	29.36	4
Halifax, Nova Scotia	30.04	+.03	30.34	9	29.72	5
Nantucket	30.03	+.04	30.44	31	29.72	20
Hatteras	30.05	+.05	30.26	31	29.84	20
Bermuda	30.14	.00	30.30	3	29.92	30
Turks Island	30.03	−.01	30.10	3	29.95	30
Key West	30.02	+.04	30.15	19	29.89	29
New Orleans	30.03	+.05	30.16	19	29.89	14

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Cyclones and gales.—The first fortnight was without any important gale. Beginning on the 15th, however, there were many reports of high winds from the vicinity of the fortieth meridian eastward to about the longitude of western Ireland, but always above the forty-fifth parallel.

Over a period of many days, pressure remained low in the general vicinity of Hudson Strait, and a succession of cyclones passed thence eastward. The lowest pressures observed occurred during the night of the 17th–18th, approximately 700 miles west of the northern tip of Ireland; two steamships noted pressures below 28.80 inches, each estimating the highest wind force as whole gale (force 10).

Even stronger winds were noted to the southeastward between noon and midnight of the 19th, close to the fiftieth parallel and between the twentieth and fifteenth meridians. Two German vessels, *Bockenheim* and *Bremen*, estimated the force as 12 (the only cases of such force observed during the month in North Atlantic waters), and the American steamship *West Eldara* as 11.

The British steamship *Langleeford* encountered gigantic waves on the 17th, the vessel then being near mid-ocean, bound from Montreal to Eastham, England. The steering apparatus was disabled for a time, and some of the crew suffered injuries.

After the 21st, conditions were less disturbed near the steamship lanes, save from the 24th to 27th, when another well-developed cyclone moved from near Newfoundland to the waters northwest of the British Isles. Late on the 24th the *West Eldara* again reported force 11, this time when about 450 miles to east-northeastward of Cape Race. The following day, winds not quite so intense were encountered by two vessels considerably farther to eastward, a short distance south of 50° latitude, near the thirty-fourth meridian, but the pressure readings this day were below 28.90 inches. (See chart IX.)

Storm in Gulf of Mexico.—As had been the case during July, no storm of consequence was encountered any considerable distance south of the Tropic of Cancer over Atlantic waters. There was, however, a LOW in the Gulf of Mexico which showed notable features in spite of being usually of no more than moderate intensity. Evidences of its development were first noted on the 24th, the position being in the eastern Gulf. Reports secured the next day indicated some gain of intensity and advance toward the west-northwest. (See chart IX.) Early on the 27th a radio report from the Italian steamship *Clara* indicated hurricane wind (force 12) from the southwest, a short distance southeast of Port Arthur, Tex.

After closely approaching the northern part of the Texas coast, on the 28th, the storm center turned southward, and finally, on the 31st, moved inland over Mexico between the Rio Grande and Tampico. The strength of this storm was not remarkable for an August storm in the Gulf, save as indicated by the one radio report mentioned.

A more detailed account of this storm will appear in the September issue of the REVIEW.

Trans-Atlantic flight.—Two Canadian fliers, James Ayling and Leonard Reid, left Wasaga Beach, Ontario, about sunrise on August 8 and landed near London, England, at 5:07 p. m., Greenwich time, the 9th, their trip requiring 31 hours, 7 minutes. Chart VIII presents the situation attending the first part of this flight.

Fog.—As usual, there was less fog in August than during the preceding month, although more than is normal for the month in mid-ocean areas and to westward. The 5° square 45° to 50° N., 45° to 50° W. experienced fog on 20 days; while the waters bordering New England and Nova Scotia had 16 days with fog.

To eastward of the thirtieth meridian there was, in general, less fog than normal for August.

OCEAN GALES AND STORMS, AUGUST 1934

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				*Inches*					
Coronado, Br. S. S.	Bristol	Bermuda	50 03 N.	8 50 W.	Aug. 1	5p, Aug. 1	Aug. 1	29.23	SSW	SW, 7	SW	SSW, 8	SSW-W-NW.
Quaker City, Am. S. S.	Halifax	London	[1]49 15 N.	41 26 W.	Aug. 15	6a, 15	Aug. 15	29.67	SSE	SSE, 8	SW	SSE, 8	6 points.
Argosy, Am. S. S.	Copenhagen	Baltimore	54 05 N.	37 20 W.	do	8p, 15	Aug. 16	[1]29.27	ESE	SW, 8	W	W, 9	ESE-SW-W.
Heddernheim, Ger. S. S.	Antwerp	Montreal	53 21 N.	31 19 W.	do	Mdt, 15	do	29.61	SSW	SSW, 8	W	SW, 9	SSW-SW.
Bockenheim, Ger. S. S.	Tampa	Rotterdam	46 50 N.	35 20 W.	Aug. 16	10p, 16	Aug. 18	29.62	S	S, 8	NW	NW, 9	S-SW.
Ivar, Dan. S. S.	Swansea	Montreal	53 50 N.	23 10 W.	Aug. 17	7p, 17	do	29.34	S	S, 6	W	WSW, 10	S-WSW.
Cameronia, Br. S. S.	Boston	Moville	53 19 N.	29 25 W.	do	Mdt, 17	do	28.78	SW	W, 10	WNW	SW, 10	SW-WNW.
Capulin, Am. S. S.	Dundee	Boston	57 40 N.	28 20 W.	do	3a, 18	do	28.76	SE	NNW, 9	W	W, 10	NE-NNW-WNW.
Badjestan, Br. S. S.	Dunstan, England.	Montreal	58 50 N.	20 29 W.	Aug. 18	4p, 18	do	29.00	SSE	S, 8	SW	S, 8	S-SW.
Statendam, Du. S. S.	New York	Rotterdam	46 17 N.	38 20 W.	do	8p, 18	do	29.51	NE	NNE, 8	N	NNE, 10	NNE-N.
Duivendrecht, Du. M. S.	New Orleans	Hamburg	[1]48 47 N.	25 50 W.	do	9a, 19	Aug. 19	29.30	S	SSW, 10	NNW	NNW, 10	S-NNW.
Washington, Am. S. S.	Cobh	New York	50 02 N.	26 00 W.	Aug. 19	9a, 19	Aug. 20	29.40	SSE	S, 8	W	N, 10	SE-S-N.
Bockenheim, Ger. S. S.	Tampa	Rotterdam	49 20 N.	19 25 W.	do	3p, 19	Aug. 19	29.23	S	NW, 12	NW	NW, 12	S-NW.
Bremen, Ger. S. S.	Cherbourg	New York	49 49 N.	16 30 W.	do	5p, 19	Aug. 20	29.29	SW	SW, 10	WSW	WNW, 12	SW-WNW.
West Eldara, Am. S. S.	Rotterdam	Boston	50 47 N.	18 00 W.	do	6p, 19	do	29.16	S	NW, 11	W	NW, 11	SSE-NW.
Dakotian, Br. S. S.	Antwerp	New York	50 23 N.	15 50 W.	do	6p, 19	do	29.29	SW	SW, 9	W	NW, 9	SW-NW-W.
West Harshaw, Am. S. S.	New Orleans	Liverpool	50 48 N.	13 50 W.	do	8p, 19	do	29.46	S	S, 10	WNW	W, 10	Steady.
Boston City, Br. S. S.	Fowey, England.	Philadelphia	49 55 N.	10 06 W.	do	Mdt, 19	do	29.64	SSW	WSW, 9	W	SW, 10	SSW-W.
General von Steuben, Ger. S. S.	Galway	New York	53 12 N.	13 18 W.	Aug. 20	2a, 20	do	29.11	ESE	NNW, 10	SW	NNW, 10	ESE-N-SW.
Volendam, Du. S. S.	Rotterdam	do	50 48 N.	18 01 W.	do	3a, 21	Aug. 21	29.38	W	SW, 8	W	SW, 8	SW-W.
Dominica, Br. S. S.	Antigua	Montserrat	16 42 N.	62 14 W.	Aug. 21	6p, 21	do	29.84	SE	SE, 7	SSE	SE, 7	SE-SSE.
West Eldara, Am. S. S.	Rotterdam	Boston	48 50 N.	42 12 W.	Aug. 24	7p, 24	Aug. 25	29.18	ENE	NNW, 11	NW	NNW, 11	ENE-NNW-NW.
Paris, Fr. S. S.	Havre	New York	49 22 N.	34 43 W.	Aug. 25	10a, 25	do	28.89	NW	W, 6	WNW	NW, 9	SSW-W-NW.
Boston City, Br. S. S.	Fowey, England.	Philadelphia	49 39 N.	33 38 W.	do	3p, 25	Aug. 26	28.88	N	NE, 3	NW	NW, 9	E-NE-N.
Black Tern, Am. S. S.	Rotterdam	New York	49 24 N.	21 53 W.	Aug. 26	1p, 26	Aug. 27	29.41	SW	W, 7	W	W, 8	SW-W.
Dirigo, Am. S. S.	Port Arthur	New Orleans	28 36 N.	92 20 W.	do	6p, 26	Aug. 26	29.54	SE	ENE, 5	SSE	SE, 9	ENE-SE.
Sapinero, Am. S. S.	Tampico	Galveston	26 09 N.	96 05 W.	Aug. 29	3p, 29	Aug. 29	29.78	NW	WNW, 7	NW	NW, 8	W-NW-N.
Princeton, Am. S. S.	Carlpeto, Venez.	New York	29 52 N.	68 18 W.	Aug. 31	8a, 30	Aug. 31	29.88	NE	SSW, 6	NE	NE, 8	SSW-N.
NORTH PACIFIC OCEAN													
Hanover, Am. S. S.	Manapela, P. I.	Los Angeles	22 52 N.	141 24 E.	Aug. 3	2p, Aug. 4	Aug. 5	29.55	NE	E, 7	SE	ENE, 7	ENE-E-SE.
Chichibu Maru, Jap. M. S.	Yokohama	Honolulu	34 30 N.	153 50 E.	Aug. 18	9p, 18	Aug. 19	29.15	NE	SE, 10	S	S, 10	SE-S.
Kiyo Maru, Jap. S. S.	Tokuyama	Los Angeles	38 01 N.	147 53 E.	Aug. 19	10p, 19	do	29.31	WNW	WNW, 7	WNW	WNW, 10	
Kwansai Maru, Jap. M. S.	Yokohama	do	39 30 N.	150 20 E.	do	8p, 19	Aug. 20	28.99	W	SW, 7	NW	NW, 8	6 points.
California, Am. S. S.	Balboa	San Diego	14 47 N.	96 47 W.	Aug. 20	4p, 20	do	29.84	N	NNE, 2	N	N, 7	
Arthur J. Baldwin, Am. S. S.	Seattle	Dutch Harbor.	54 30 N.	156 05 W.	Aug. 22	1a, 23	Aug. 22	29.97	SSW	W, 4	S	S, 10	S-W.

[1] Position approximate.

[2] Barometer uncorrected.

NORTH PACIFIC OCEAN, AUGUST 1934

By WILLIS E. HURD

Atmospheric pressure.—Average pressures for the American Pacific coastal region and adjacent islands were above normal in August 1934. The departures ranged between +.05 at San Francisco and +.17 at Kodiak. Abnormally high average pressures for the month were also recorded at the Nansei and Ogasawara Islands, in Asiatic waters. Pressures below normal were indicated at Manila, Guam, and Midway Island.

The Aleutian cyclone appeared as a comparatively shallow development over the Bering Sea. Anticyclonic conditions were strongly marked over most of the eastern half of the North Pacific. In the extreme western Pacific very little high-pressure movement occurred south of the 40th parallel.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, August 1934 at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow	30.06	+0.17	30.46	21	29.64	30
Dutch Harbor	29.95	+.09	30.30	9	29.40	29
St. Paul	29.90	+.12	30.26	10	29.40	30
Kodiak	30.03	+.17	30.26	28	29.68	30
Juneau	30.12	+.10	30.39	20	29.70	1
Totoosh Island	30.09	+.09	30.30	7	29.87	2
San Francisco	29.97	+.05	30.08	5	29.77	18
Mazatlan	29.90	+.06	30.00	20	29.82	30
Honolulu	30.01	.00	30.11	2	29.89	31
Midway Island	30.03	−.05	30.24	5	29.74	20
Guam	29.81	−.01	29.90	26	29.70	2
Manila	29.76	−.04	29.88	27	29.68	6, 7
Hong Kong	29.72	.....	29.85	28	29.61	8
Naha	29.79	+.10	29.96	15	28.76	6
Chichishima	29.89	+.13	30.06	7	29.68	17
Nemuro	29.84	.....	30.22	1	29.48	24

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Cyclones and gales.—Quiet summer weather prevailed over most of the North Pacific Ocean throughout August. The few extra-tropical cyclones of the month ran mostly in high latitudes and were of a mild type. Only 1 high-latitude gale was reported; that was of force 8 and was experienced at some distance southeast of the Peninsula of Alaska on the 22d.

Typhoons.—The situation with respect to typhoons this month is rather obscure, but it is evident that two or three tropical storms occurred in the southwestern North Pacific, in addition to that mentioned in Father Doucette's accompanying paper as appearing in the South China Sea.

The Tokyo weather charts show two typhoons as forming simultaneously on the 1st of August—one near Yap; the other over the southern Marianas. In connection with the easternmost of these storm centers, there is the report of the American S. S. *Hanover* that an east gale of force 7, barometer 29.55 inches, was experienced on the 4th near 23° N., 141° E. In their northward movement, these centers appear to have coalesced on the 5th to the southeastward of the Nansei Islands. On the 6th the resultant typhoon crossed the Nanseis, where an observation from Naha gave an east wind of force 8 and a barometer reading of 28.76 inches. On the 7th and 8th the center moved westward, then northward across the Yellow Sea, accompanied by gales of at least force 9, as indicated by the Tokyo maps, and by a pressure fall to 28.50 inches, on the 7th, in 29° N., 125° E. On the 10th or 11th the typhoon was last observed as a shallow depression in the Japan Sea.

A cyclonic development that lay southeast, then east, of Honshu, Japan, on the 18th and 19th, caused stormy weather between the island and approximately longitude 160° E. Gales of force 10 were reported by ships on both days, and on the 19th a barometer fall to 28.99 inches was recorded near 40° N., 150° E. This storm appears to have been first experienced as a well developed cyclone on the 16th, near 25° N., 153° E., whence it progressed northward and on the 21st crossed the Kuril Islands into the Okhotsk Sea.

Fog.—Along the American coast 1 day with fog was reported off Lower California; 8 days, off California; and 5 days, off Oregon and Washington. During the night of the 9th the British S. S. *Northholm* ran aground in dense fog near Ocean Falls, British Columbia, but was refloated, with slight damage, on the 10th. The great fog belt of the month lay mostly north of the 40th parallel to the westward of the 150th meridian of west longitude, with 10 percent to 30 percent or more of days of occurrence. The area of maximum frequency lay between the Kuril Islands and 170° E.

As an evidence of the possibilities of fogginess attending trans-Pacific passages this month, it is of some interest to cite the following notations: The American S. S. *Potter* ran in mostly dense fog from the 3d to the 8th, between 43° N., 167° E., and 45° N., 157° W. The Danish M. S. *Anna Maersk* reported dense fog from the 8th to the 14th, between 43° N., 166° W., and 38½° N., 150° E. The American S. S. *President Jefferson* encountered fog daily from the 8th, near 53° N., 157° W., until the 16th when near the east coast of central Japan.

TYPHOONS IN THE FAR EAST, AUGUST 1934

BERNARD F. DOUCETTE, S. J.

[Chief, Meteorological Division, Philippine Island Weather Bureau]

Three typhoons occurred in the Pacific Ocean, and one in the Gulf of Tong King, during August 1934.

On July 30 and 31, a depression or typhoon passed south of Guam on a NW. course and was located August 1 near longitude 140° E., latitude 14° N. Moving WNW. for two days, it changed its direction August 3 (longitude 130° E., latitude 16° 30′ N.) to the NW. It was thought that the center was near longitude 126° 30′ E., latitude 18° N. on August 5. No trace of the typhoon could be found the next day because of the proximity of the larger typhoon which followed it across the Pacific.

From longitude 149° E., latitude 16° N., a typhoon moved, August 1 and 2, NW. to longitude 145° E., latitude 17° 30′ N. The next two days it moved W., changing to a NW. course on August 4 at longitude 139° E., latitude 17° 30′ N. August 6 found it at longitude 131° E., latitude 22° N., and the next day at longitude 128° E., latitude 28° N., close to and NNE. of Naha. It began to recurve at longitude 123° 30′ E., latitude 30° 30′ N., August 8, taking a northerly course and then inclining to the NE., crossing Korea August 10. On August 11 it was almost across the Sea of Japan, and on August 12 it was in the Pacific Ocean close to longitude 145° E., latitude 41° N., moving E.

A depression appeared on August 24, 6 a. m. close to the southern coast of Hainan. It moved NW. and the next day found it a well-developed typhoon very close to and west of Phulien. It continued on its NW. course, but no trace of it was found on the weather map of the next day.

The S. S. *Bengalen*, en route from San Francisco to Manila, passed close to and south of a typhoon located, from the observations taken on board, at longitude 153° E., latitude 25° N., August 16th, and at longitude 155° E., latitude 26° N., August 17. The lowest reading of the barometer, made 9 p. m., August 16, was 739.8 millimeters (29.13 inches). At the present writing, data for determining the origin and entire course of this typhoon are not available.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, August 1934

[For description of tables and charts, see Review, January, p. 37]

Section	Temperature								Precipitation					
			Monthly extremes								Greatest monthly		Least monthly	
	Section average	Departure from the normal	Station	Highest	Date	Station	Lowest	Date	Section average	Departure from the normal	Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	80.9	+1.2	Florence	104	6	2 stations	59	23	6.01	+1.48	Brewton	13.62	Riverton	1.36
Arizona	80.1	+.1	5 stations	116	[1] 1	Fort Valley	42	[1] 6	3.17	+.88	Prescott	8.70	Mohawk	.02
Arkansas	84.8	+5.0	Lead Hill	116	9	Dutton	48	30	2.75	−.75	St. Francis	7.43	Hope	.12
California	73.2	+.8	Greenland Ranch	121	18	Sierraville	30	[1] 17	.11	+.02	Campo	2.29	103 stations	.00
Colorado	69.4	+4.1	3 stations	108	[1] 5	Fraser	24	25	1.59	−.37	2 stations	5.53	Boulder	.21
Florida	81.4	.0	Raiford	99	9	Raiford	64	30	5.40	−1.62	Belle Glade	12.41	Orlando	1.27
Georgia	80.8	+1.4	Millen	102	6	Clayton	55	29	5.14	−.02	Brunswick	12.30	Stillmore	1.55
Idaho	68.9	+2.5	Cambridge	110	15	Warren	27	[1] 23	.21	−.40	Bostetter Ranger Station.	1.11	11 stations	.00
Illinois	75.4	+1.5	La Harpe	113	9	Mount Carroll	33	[1] 25	3.79	+.43	Tuscala	9.45	Keithsburg	1.4
Indiana	74.2	+1.0	Collegeville	107	9	4 stations	40	3	4.68	+1.29	Greencastle	10.35	Mount Vernon	1.4
Iowa	73.4	+1.5	Keokuk no. 2	116	9	Decorah	33	29	2.84	−.72	Muscantine	7.21	Corning	.66
Kansas	83.6	+6.2	Phillipsburg	117	6	2 stations	40	25	1.32	−1.85	Coffeyville	5.52	Burlington	T
Kentucky	76.6	+1.0	Franklin	104	12	Quicksand	46	30	4.76	+1.04	Pikeville	10.84	Cold Spring	1.61
Louisiana	83.3	+1.5	2 stations	108	8	2 stations	63	30	5.44	+.37	Delta Farms	14.97	Logansport	.00
Maryland-Delaware	72.1	−1.1	Keedysville, Md	97	14	Grantsville, Md	32	30	4.99	+.67	Cecilton, Md	11.50	Annapolis, Md	2.50
Michigan	65.2	−1.4	5 channels	103	9	Dukes	23	29	2.47	−.18	Hart	6.70	Ann Arbor	.74
Minnesota	66.0	−1.2	Pipestone	104	4	Big Falls	25	28	2.07	−1.08	Worthington	5.31	Red Lake Falls	.57
Mississippi	83.1	+2.5	Austin	107	8	Batesville	59	30	3.91	−.40	Bay St. Louis	11.02	Stoneville	.40
Missouri	80.6	+4.4	Downing	115	9	Grant City	41	25	3.90	−.04	Greenville	10.47	Appleton City	.07
Montana	66.6	+1.9	3 stations	109	3	Forks (near)	24	24	.33	−.82	Conway's Ranch	2.00	8 stations	.00
Nebraska	76.4	+3.5	Ashland	115	5	Weeping Water	35	24	1.67	−1.15	Wauneta	4.51	Santee	.26
Nevada	74.3	+4.1	Logandale	117	13	Canyon Creek Ranch.	28	20	.30	−.22	Searchlight	2.22	5 stations	.00
New England	64.7	−2.1	3 stations	93	10	Somerset, Vt	30	31	2.36	−1.53	Westfield, Mass	5.90	Lakeport, N. H	.74
New Jersey	69.8	−2.0	Burlington	100	10	2 stations	33	30	3.61	−1.14	Bridgeton	9.11	Sussex	1.40
New Mexico	73.3	+2.7	Nara Visa	111	11	Lake Alice	31	28	2.57	+.10	2 stations	8.06	Pennington	.19
New York	65.3	−2.0	Lowville	97	8	Franklinville	26	30	2.38	−1.42	Franklinville	5.21	Dannemora	.46
North Carolina	76.9	+1.1	Monroe	101	4	Banners Elk	44	29	5.63	+.10	Swansboro	19.90	Marshall	1.23
North Dakota	67.4	+1.2	New Salem	108	17	2 stations	25	[1] 23	1.15	−.89	Ellendale	3.06	Frybury	.06
Ohio	71.9	+.4	3 stations	103	9	Millport	35	30	4.20	+.87	Summerfield	7.84	Hamilton	1.12
Oklahoma	87.0	+5.8	Mutual	116	1	Boise City	50	25	2.57	−.44	Fort Reno	8.53	Atoka	.05
Oregon	67.2	+1.8	3 stations	105	[1] 25	2 stations	24	[1] 4	.26	−.17	Seaside	2.68	10 stations	.00
Pennsylvania	68.6	−1.4	2 stations	98	[1] 10	Brookville	30	30	4.94	+.77	Mount Lebanon	10.49	Montrose	1.27
South Carolina	70.9	+1.1	do	102	[1] 4	Caesars Head	53	31	5.02	−.68	Caesars Head	10.10	Aiken	.83
South Dakota	72.1	+1.7	4 stations	116	4	La Delle	28	24	1.32	−.99	Sioux Falls	3.62	Pollock	.00
Tennessee	79.3	+2.8	2 stations	109	7	2 stations	51	30	4.85	+.80	Decatur	13.79	Brownsville	.48
Texas	85.2	+2.4	McKinney	113	13	5 stations	53	[1] 24	1.27	−1.17	Galveston	9.35	3 stations	.00
Utah	72.9	+3.3	St. George	108	[1] 1	Thistle	32	1	.99	−.06	Bryce Canyon	4.18	Leeds (near)	T
Virginia	74.1	+.1	Charlottesville	100	14	Mineral	39	23	4.43	+.08	Emory	9.20	Floyd	1.20
Washington	67.1	+1.2	Wahluke	110	15	2 stations	32	[1] 4	.54	−.22	Quinault	3.67	Ellensburg	.00
West Virginia	71.6	.0	Charleston (Dam No. 6 G. K.).	99	9	Bayard	35	[1] 29	5.37	+1.35	Williamson	9.28	Marlinton	1.56
Wisconsin	65.8	−1.5	Fond du Lac	101	9	Long Lake	25	28	2.76	−.41	Stevens Point	4.91	Waukesha	.66
Wyoming	65.6	+1.9	Colony	107	3	Lake Yellowstone	21	21	.68	−.43	Pine Bluffs	2.47	Worland	.03
Alaska (July)	54.4	−1.7	Wrangell	92	25	2 stations	26	[1] 10	2.35	−.41	Perseverance Camp	6.70	Barrow	.02
Hawaii	76.4	+1.6	3 stations	94	[1] 4	Kanalohuluhulu	49	26	3.79	−3.34	Puu Kukui (upper)	15.00	2 stations	.00
Puerto Rico	78.8	−.2	Guayama	95	20	Guineo Reservoir	51	10	7.18	−.05	Maricao	18.30	Quebradillas	1.40

[1] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, August 1934*

[Compiled by Annie E. Small]

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max.+mean min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month.
New England	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F.*		*°F.*	*°F.*		*°F.*	*°F.*	*°F.*	*°F.*	*%*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
							65.3	−2.0										75	1.93	−1.7										5.0		
Eastport	76	67	85	29.94	30.02	+0.06	59.6	−1.1	75	4	67	47	31	52	24	55	53	82	2.64	−0.4	9	6,306	sw.	28	s.	3	9	14	8	5.7	0.0	0.0
Greenville, Maine	1,070	6	40	28.88	30.01	------	59.6	------	83	18	70	39	16	49	35	------	------	11	3,537	nw.	22	------	24	12	12	7	------	------	------	------	------
Portland, Maine	103	82	117	29.90	30.02	+.04	64.7	−1.7	84	20	73	49	6	56	25	58	54	71	1.10	−2.0	7	6,352	s.	25	nw.	5	16	11	4	3.2	.0	.0
Concord	289	60	------	------	------	------	64.0	−2.8	90	19	76	38	31	52	38	------	------	------	1.39	−2.2	8	------	------	------	------	------	12	15	4	------	.0	.0
Burlington	403	11	48	29.58	30.01	+.04	64.7	−3.2	89	19	75	41	31	54	32	------	------	------	1.31	−2.1	9	6,901	s.	30	s.	2	12	12	7	4.9	.0	.0
Northfield	876	12	60	29.10	30.04	+.06	60.0	−3.4	88	19	74	32	31	46	41	55	52	78	1.95	−1.6	9	5,112	s.	25	s.	2	8	14	9	5.3	.0	.0
Boston	124	336	360	29.89	30.03	+.04	67.3	−2.6	86	10	75	50	30	60	23	60	56	70	1.83	−1.8	9	9,509	sw.	32	nw.	5	6	18	7	5.4	.0	.0
Nantucket	12	14	90	30.02	30.03	+.04	67.2	−.6	81	2	74	54	30	61	18	62	60	82	2.21	−1.2	10	9,174	s.	33	ne.	13	12	9	10	5.0	.0	.0
Block Island	26	11	46	30.00	30.03	+.04	67.6	−.9	80	2	74	54	31	61	19	63	61	83	1.50	−2.2	9	9,336	sw.	30	nw.	5	10	13	8	5.5	.0	.0
Providence	160	215	251	29.86	30.03	+.04	68.0	−3.0	87	10	77	49	31	59	25	61	56	69	2.34	−1.2	8	7,247	nw.	37	nw.	5	17	3	11	4.5	.0	.0
Hartford	159	70	104	------	30.03	+.04	68.0	−.9	87	10	77	45	31	59	28	------	------	------	2.54	−1.8	9	4,954	s.	------	------	------	11	8	12	------	.0	.0
New Haven	106	74	153	29.94	30.04	+.05	68.6	−1.7	87	10	77	48	31	60	26	62	58	70	2.45	−1.8	8	6,208	s.	28	s.	2	9	10	12	5.4	.0	.0
Middle Atlantic States							72.1	−1.3										74	3.82	−0.5										5.9		
Albany	97	107	115	29.93	30.03	+.05	67.6	−3.2	89	10	77	45	31	58	31	60	56	70	2.76	−1.0	8	5,231	s.	22	s.	2	11	13	7	5.1	.0	.0
Binghamton	871	60	68	29.12	30.05	+.06	65.5	−2.5	91	10	76	37	31	55	36	------	------	------	3.23	−.4	11	3,729	ne.	17	s.	2	7	7	17	6.8	.0	.0
New York	314	415	454	29.70	30.03	+.03	70.4	−2.7	86	11	77	52	30	63	21	63	57	73	1.74	−2.6	9	9,077	s.	34	nw.	5	12	8	11	5.2	.0	.0
Bellefonte	1,050	5	42	28.95	30.04	------	65.6	------	90	10	76	36	30	55	36	61	59	83	3.96	------	12	------	sw.	------	------	------	11	9	11	5.8	.0	.0
Harrisburg	374	94	104	29.64	30.03	+.02	70.6	−2.0	91	10	79	48	31	62	26	63	59	72	5.08	+1.0	12	4,629	ne.	25	w.	10	13	5	13	5.5	.0	.0
Philadelphia	114	123	367	29.93	30.05	+.05	73.2	−1.6	89	14	80	54	30	66	21	65	60	69	4.29	−.3	12	7,961	s.	31	e.	12	10	5	16	5.8	.0	.0
Reading	323	283	306	29.69	30.04	------	70.1	−2.3	87	14	78	47	31	62	28	63	59	72	2.11	−2.1	12	6,756	s.	34	nw.	3	11	12	8	5.2	.0	.0
Scranton	805	72	104	29.19	30.04	+.04	67.1	−2.7	86	8	76	41	30	58	33	60	57	74	2.75	−.9	10	4,408	n.	18	nw.	10	6	14	11	5.7	.0	.0
Atlantic City	52	37	172	29.99	30.04	+.04	71.8	−.7	89	20	78	53	30	66	23	66	64	79	5.00	+.5	10	9,653	s.	37	ne.	12	7	9	15	6.4	.0	.0
Sandy Hook	22	10	57	30.01	30.03	------	70.9	------	87	10	77	56	30	65	18	65	61	76	2.09	−2.9	8	9,012	s.	30	ne.	12	12	7	12	5.3	.0	.0
Trenton	190	88	106	29.84	30.04	------	70.5	−2.5	88	14	80	49	30	62	26	64	60	73	2.59	−2.2	11	6,192	s.	24	w.	3	9	8	14	6.1	.0	.0
Baltimore	123	100	215	29.91	30.03	+.02	74.7	−.8	93	15	82	53	31	67	24	66	62	71	6.63	+2.3	9	6,647	sw.	33	nw.	15	7	10	14	6.0	.0	.0
Washington	112	62	85	29.92	30.04	+.03	74.1	−.9	92	15	83	49	31	66	27	67	63	75	5.21	+1.2	9	4,022	sw.	38	nw.	15	8	11	12	5.7	.0	.0
Cape Henry	18	8	54	30.02	30.04	------	77.0	+.1	94	16	83	63	28	71	22	71	69	80	5.06	+.2	12	7,675	sw.	38	nw.	16	6	14	11	6.2	.0	.0
Lynchburg	686	5	------	29.32	30.06	+.04	76.4	+.8	96	11	86	54	31	66	29	------	------	------	4.69	+.9	15	------	n.	------	------	------	1	22	8	------	.0	.0
Norfolk	91	170	205	29.96	30.06	+.06	77.6	+.2	92	15	84	63	31	71	19	71	68	80	4.37	−.8	10	7,962	s.	40	w.	16	4	12	15	7.1	.0	.0
Richmond	144	11	52	29.91	30.05	+.04	76.1	−.4	93	15	84	50	31	68	25	69	67	80	3.22	−1.2	14	4,986	sw.	30	nw.	16	6	8	17	6.5	.0	.0
Wytheville	2,304	49	55	------	30.03	+.02	70.7	+.2	87	13	79	51	27	63	24	------	------	------	4.04	−.2	17	5,944	w.	20	w.	16	1	14	16	------	.0	.0
South Atlantic States							73.8	+1.5										82	5.34	−0.4										6.3		
Asheville	2,253	89	104	27.78	30.06	+.04	73.8	+3.3	90	11	83	54	29	64	28	67	65	83	1.59	−2.6	13	4,392	s.	21	nw.	1	2	15	14	6.6	.0	.0
Charlotte	779	63	86	29.24	30.06	+.04	78.6	+1.5	96	20	86	60	31	71	22	71	69	79	4.23	−.8	14	5,456	sw.	24	se.	8	1	11	19	7.3	.0	.0
Greensboro	886	6	56	29.12	30.06	------	76.8	------	93	16	86	54	31	68	25	70	69	86	2.25	------	14	4,913	sw.	34	nw.	25	1	10	20	7.8	.0	.0
Hatteras	11	5	50	30.04	30.05	+.05	79.0	+1.0	89	1	84	68	31	74	17	74	72	81	5.22	−.5	10	8,371	sw.	37	nw.	5	8	14	9	5.3	.0	.0
Raleigh	376	103	146	29.65	30.04	+.03	78.1	+1.1	94	20	86	56	31	70	21	71	69	81	6.51	+1.1	10	5,647	sw.	30	nw.	25	1	10	20	7.6	.0	.0
Wilmington	72	73	107	29.99	30.06	+.06	80.2	+2.6	93	5	87	57	31	73	23	74	72	82	5.28	−1.1	15	6,687	sw.	27	n.	5	5	15	11	6.1	.0	.0
Charleston	48	11	92	30.02	30.07	+.06	82.2	+1.2	96	4	88	64	31	76	20	76	74	82	7.05	+.5	16	7,294	sw.	26	nw.	17	4	16	11	6.2	.0	.0
Columbia, S. C.	351	41	57	29.68	30.05	+.04	80.7	+1.1	98	4	90	61	31	72	27	73	71	81	3.69	−1.8	8	5,035	sw.	21	sw.	23	5	18	8	5.8	.0	.0
Augusta	182	62	77	29.85	30.04	+.03	81.7	+1.3	98	4	91	63	31	73	23	74	72	80	3.41	−1.6	9	4,140	s.	19	nw.	4	5	16	10	6.3	.0	.0
Savannah	65	73	152	29.99	30.06	+.05	81.8	+1.1	96	20	90	65	31	73	23	74	72	82	10.40	+3.1	11	6,800	sw.	45	n.	27	9	17	5	5.2	.0	.0
Jacksonville	43	86	110	30.03	30.08	+.07	82.2	+.5	94	5	90	67	30	74	21	74	73	81	5.98	+.2	15	5,113	s.	23	w.	3	11	14	6	4.7	.0	.0
Florida Peninsula							82.6	+0.4										76	3.85	−2.5										5.1		
Key West	22	10	64	30.00	30.02	+.04	83.4	−.1	91	30	89	72	12	78	16	76	74	74	2.24	−2.3	20	6,081	e.	30	nw.	30	12	13	6	5.1	.0	.0
Miami	25	124	168	30.03	30.06	+.04	82.1	+.7	93	30	88	71	11	76	19	76	73	75	3.20	−3.0	17	6,051	se.	24	sw.	7	4	18	9	6.1	.0	.0
Tampa	35	88	197	30.03	30.06	+.06	82.2	+.7	93	23	90	70	31	74	20	74	73	80	6.10	−2.1	15	6,507	e.	29	ne.	31	13	14	4	4.2	.0	.0
Titusville	43	5	36	30.02	30.07	------	81.2	------	94	20	91	68	8	72	23	------	------	------	5.43	------	11	------	se.	------	------	------	15	12	4	------	.0	.0
East Gulf States							81.0	+1.1										82	6.27	+0.9										6.1		
Atlanta	1,173	128	135	28.85	30.06	+.05	78.4	+1.4	92	4	87	64	4	70	28	72	69	80	3.32	−1.1	11	5,604	w.	30	n.	4	0	18	13	7.0	.0	.0
Macon	370	79	87	29.67	30.06	+.05	80.9	+1.0	95	4	90	66	31	72	27	73	71	79	5.08	+.7	15	4,191	s.	27	n.	4	3	21	7	6.0	.0	.0
Thomasville	273	49	58	29.79	30.08	+.08	80.6	−.4	95	17	90	62	12	71	25	74	72	83	3.32	------	13	------	sw.	------	------	------	2	16	13	------	.0	.0
Apalachicola	35	11	51	30.01	30.05	------	81.6	------	91	11	88	70	31	76	16	76	------	------	4.70	−2.8	17	------	ne.	------	------	------	4	24	3	------	.0	.0
Pensacola	56	149	185	29.99	30.05	+.07	80.6	−.3	91	5	86	68	6	75	23	75	73	82	8.88	+.9	14	7,301	s.	46	ne.	5	8	17	6	5.0	.0	.0
Anniston	741	9	------	------	------	------	79.8	+3.4	94	6	89	62	30	71	24	------	------	------	8.22	------	10	------	se.	------	------	------	7	13	11	------	.0	.0
Birmingham	700	11	48	29.30	30.05	+.06	80.2	+1.0	96	5	89	66	30	72	24	73	71	84	9.25	+5.0	11	4,090	s.	21	se.	12	6	13	12	6.0	.0	.0
Mobile	57	125	161	29.98	30.04	+.06	81.6	+.6	93	7	89	70	6	74	22	75	73	83	7.59	+.7	15	5,668	s.	29	n.	8	3	18	10	6.3	.0	.0
Montgomery	218	92	105	29.82	30.06	+.07	81.1	+.3	96	6	90	68	29	73	24	74	72	83	4.19	−.0	13	4,281	sw.	21	ne.	11	4	17	10	6.5	.0	.0
Meridian	375	67	92	29.65	30.03	+.05	81.8	+2.3	98	7	92	67	30	72	26	74	72	83	3.89	−.6	10	3,826	sw.	26	ne.	6	9	11	11	5.4	.0	.0
Vicksburg	247	65	73	29.77	30.03	+.05	83.0	+2.2	97	8	92	68	29	74	22	74	72	78	4.35	+.9	5	5,078	s.	25	e.	12	7	13	11	6.1	.0	.0
New Orleans	53	76	84	29.98	30.03	+.05	83.0	+.8	94	7	90	71	8	76	22	76	74	81	11.46	+5.7	18	4,250	sw.	25	ne.	8	1	17	13	6.8	.0	.0
West Gulf States							85.0	+3.0										69	1.93	−1.2										4.2		
Shreveport	249	92	227	29.73	29.99	+.02	86.6	+4.6	102	8	97	69	30	76	28	74	70	64	.73	−2.0	2	7,171	sw.	34	ne.	9	18	15	1	3.7	.0	.0
Bentonville	1,303	11	44	28.62	29.94	−.03	83.2	+6.7	106	9	95	58	30	71	32	------	------	------	4.43	------	8	4,430	s.	21	se.	16	11	9	11	------	.0	.0
Fort Smith	457	79	94	29.48	29.94	−.03	87.8	+7.3	109	9	99	66	30	76	31	71	63	53	1.68	−1.6	7	5,451	e.	21	e.	16	9	15	7	5.0	.0	.0
Little Rock	357	94	102	29.62	29.99	+.01	84.6	+4.8	105	8	95	63	30	74	33	72	67	62	2.15	−1.6	6	5,945	sw.	28	ne.	3	10	15	6	5.0	.0	.0
Austin	605	136	148	29.34	29.97	------	85.2	+1.4	99	13	96	71	27	75	24	73	69	66	.46	−1.6	5	6,303	s.	22	s.	2	18	11	2	3.7	.0	.0
Brownsville	57	88	96	29.88	29.94	------	83.6	−.3	96	28	91	70	1	76	22	76	74	80	.98	−1.6	7	7,941	se.	27	se.	23	14	14	3	4.0	.0	.0
Corpus Christi	20	11	78	29.97	29.99	+.06	83.8	+1.3	97	27	89	76	29	78	20	77	75	81	.15	−2.1	3	8,416	s.	24	se.	2	12	15	4	4.8	.0	.0
Dallas	512	220	227	29.42	29.95	------	87.6	------	103	14	97	70	26	78	23	72	65	53	.24	−2.5	3	7,701	s.	43	ne.	26	19	10	2	3.5	.0	.0
Fort Worth	670	106	114	29.28	29.97	+.03	88.3	+5.3	103	13	98	72	25	78	24	------	------	------	.13	−2.5	4	7,261	sw.	27	e.	9	25	6	0	1.7	.0	.0
Galveston	54	106	114	29.94	30.00	+.04	83.2	+.2	90	18	87	71	26	79	17	77	75	79	9.35	+5.1	9	8,141	s.	41	ne.	27	16	7	8	4.5	.0	.0
Houston	138	292	314	29.86	30.00	------	83.5	+.3	96	19	92	70	30	76	23	------	------	------	1.61	−2.6	9	7,745	s.	32	ne.	27	10	17	4	4.8	.0	.0
Palestine	510	64	72	29.47	29.99	+.02	85.3	+3.5	101	9	96	69	30	74	29	73	69	67	1.48	−.7	3	5,590	s.	25	e.	9	16	12	3	3.8	.0	.0
Port Arthur	34	58	66	29.96	30.00	------	83.4	------	95	9	90	72	29	77	19	76	74	80	5.26	−.8	12	6,133	s.	34	ne.	27	9	18	4	4.9	.0	.0
San Antonio	693	242	301	29.25	29.95	+.02	84.6	+1.1	99	21	94	71	2	75	25	73	69	69	.88	−1.5	3	8,261	se.	32	ne.	26	6	22	3	4.8	.0	.0

TABLE 1.—*Climatological data for Weather Bureau stations, August 1934*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max.+mean min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F.*		*°F.*	*°F.*		*°F.*	*°F.*	*°F.*	*°F.*	*%*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
							76.1	+1.0										73	4.36	+0.9										5.9		
Chattanooga	762	71	214	29.25	30.04	+0.04	80.4	+2.9	96	4	89	63	29	72	24	72	70	76	6.50	+2.5	15	4,671	w.	24	n.	25	4	15	12	6.6	0.0	0.0
Knoxville	995	66	84	29.01	30.04	+.03	78.4	+2.2	93	9	87	61	29	69	25	71	68	80	7.47	+3.6	15	3,677	sw.	21	e.	13	5	15	11	6.6	.0	.0
Memphis	399	78	86	29.58	29.99	+.01	83.4	+4.0	105	8	92	62	30	75	24	73	69	68	2.19	−1.2	7	5,345	sw.	21	ne.	13	5	16	10	6.0	.0	.0
Nashville	546	168	191	29.46	30.03	+.03	80.2	+2.4	98	8	89	60	30	72	25	71	68	73	1.87	−1.8	8	5,597	sw.	24	nw.	1	4	12	15	7.1	.0	.0
Lexington	989	5																													
Louisville	525	188	234	29.46	30.03	+.03	76.8	−.2	94	9	86	53	30	68	29	68	64	71	4.91	+1.5	15	6,278	s.	35	n.	10	9	11	11	5.6	.0	.0
Evansville	431	76	116	29.55	30.00	+.01	77.7	+.3	94	9	86	53	29	69	31	70	66	72	3.66	+.3	10	5,572	s.	26	sw.	2	8	8	15	6.0	.0	.0
Indianapolis	822	194	230	29.16	30.03	+.03	74.2	+.5	97	9	83	48	29	65	26	65	61	67	2.49	−.8	15	6,682	s.	24	n.	10	7	13	11	5.9	.0	.0
Terre Haute	575	96	129	29.40	30.00		75.2		96	9	84	47	29	66	26	67	64	72	4.63	+1.4	14	5,883	s.	24	n.	10	10	15	6	4.8	.0	.0
Cincinnati	627	11	51	29.36	30.02	+.01	76.2	+2.6	97	9	87	51	30	66	36	66	62	68	1.72	−1.7	9	4,405	sw.	22	n.	9	7	12	12	5.7	.0	.0
Columbus	822	216	230	29.16	30.02	+.01	73.2	+.2	96	9	83	50	29	64	28	64	60	67	4.13	+.9	10	6,591	s.	42	n.	9	6	16	9	5.6	.0	.0
Elkins	1,947	59	78	28.07	30.07	+.05	68.6	−.5	86	7	79	43	30	58	32	63	61	86	4.93	+1.1	14	3,484	nw.	24	n.	3	4	14	13	6.5	.0	.0
Parkersburg	637	77	84	29.42	30.06	+.05	73.7	−.2	95	9	84	49	30	64	32	66	64	76	4.69	+1.2	10	3,885	se.	27	nw.	3	13	7	11	5.2	.0	.0
Pittsburgh	842	353	410	29.14	30.04	+.03	70.7	−2.2	90	9	80	46	30	61	29	63	59	72	7.47	+4.2	12	5,862	sw.	42	nw.	2	9	12	10	5.6	.0	.0
Lower Lake Region							68.3	−1.3										66	2.24	−0.8										4.9		
Buffalo	768	243	280	29.19	30.01	+.02	66.8	−1.8	93	8	74	49	30	59	27	59	54	67	1.18	−1.9	6	8,618	sw.	43	w.	2	12	12	7	4.7	.0	.0
Canton	448	10	61	29.52	29.99		64.4	−3.4	93	8	77	36	30	52	39				.95	−2.7	8	5,600	sw.	29	sw.	19	9	15	7	5.3	.0	.0
Ithaca	836	77	100	29.14	30.04		66.0	−2.6	92	10	77	38	31	55	36	59	55	74	3.86	+.5	11	5,888	nw.	22	s.	2	8	11	12	5.8	.0	.0
Oswego	335	71	85	29.66	30.02	+.03	65.6	−2.8	92	19	74	45	31	58	29	59	54	67	1.07	−1.5	6	6,356	s.	25	n.	28	10	13	8	5.2	.0	.0
Rochester	523	86	102	29.47	30.03	+.04	67.3	−1.9	94	8	76	44	30	58	29	58	53	62	1.76	−1.1	8	5,551	sw.	21	sw.	19	9	16	6	5.3	.0	.0
Syracuse	596	65	79	29.40	30.04	+.05	67.6	−1.0	92	8	77	42	31	58	34				2.09	−.8	11	5,000	s.	21	nw.	24	9	14	8	5.6	.0	.0
Erie	714	130	166	29.27	30.02	+.01	68.7	−.9	92	8	77	49	30	61	28	61	57	69	3.15	−.1	9	8,061	n.	30	s.	19	13	14	4	4.0	.0	.0
Cleveland	762	267	337	29.21	30.02	+.01	70.0	.0	93	8	77	50	30	63	27	62	57	66	2.46	−.3	11	8,190	n.	44	n.	2	12	13	6	4.7	.0	.0
Sandusky	629	5	67	29.36	30.03	+.02	71.4	−.4	98	8	81	46	30	62	33				2.99	−.2	11	5,464	s.	27	n.	2	9	12	10	5.1	.0	.0
Toledo	628	79	87	29.36	30.03	+.03	71.1	−.2	96	9	80	46	29	62	28	62	56	64	1.80	−1.1	8	5,844	sw.	26	w.	19	17	11	3	3.5	.0	.0
Fort Wayne	857	69	84	29.11	30.02		72.0	+.9	102	9	82	47	30	62	28	62	57	64	3.75	+.6	11	5,476	se.	30	sw.	2	8	15	8	5.5	.0	.0
Detroit	626	5	78	29.35	30.03	+.02	69.2	−1.1	93	8	80	43	30	58	32	60	55	64	1.84	−.9	7	6,089	ne.	32	nw.	2	12	12	7	4.6	.0	.0
Upper Lake Region							68.8	−1.4										70	2.39	−0.5										5.0		
Alpena	609	13	89	29.37	30.04	+.04	61.7	−2.4	90	9	72	39	29	52	31	56	52	72	1.38	−1.5	12	7,543	nw.	34	s.	19	14	13	4	4.1	.0	.0
Escanaba	612	54	60	29.36	30.02	+.03	61.0	−3.3	83	9	70	37	29	52	28	56	52	73	2.68	−.5	9	6,765	s.	27	nw.	19	9	15	7	5.0	.0	.0
Grand Rapids	707	70	244	29.26	30.01	+.01	69.8	+.1	97	9	81	44	29	59	31	60	54	63	1.62	−1.0	10	6,977	n.	34	nw.	19	13	9	9	4.5	.0	.0
Lansing	878	6	88	29.09	30.02		67.2	−1.3	95	9	79	41	29	55	33	60	56	74	1.51	−1.3	6	5,580	s.	29	nw.	2	11	13	7	4.9	.0	.0
Ludington	637	5	54	29.33	30.02		64.4	−.9	86	9	73	37	29	56	35	59			4.32	+1.7	9						12	8	11		.0	.0
Marquette	734	77	111	29.22	30.01	+.03	61.0	−2.8	94	18	70	38	29	52	36	54	50	68	1.83	−.8	7	6,778	w.	32	w.	19	6	17	8	5.6	.0	.0
Sault Sainte Marie	614	11	52	29.33	30.02	+.03	59.4	−2.7	87	17	70	40	25	49	32	54	50	76	2.02	−.6	11	5,558	nw.	32	nw.	19	8	19	4	5.0	.0	.0
Chicago	673	7	131	29.30	30.02	+.02	72.4	+.8	100	8	80	50	25	65	26	63	59	67	3.41	+.2	10	6,726	ne.	24	ne.	10	9	15	7	5.2	.0	.0
Green Bay	617	109	141	29.35	30.00	+.01	65.6	−2.1	94	9	76	40	29	56	29	59	54	70	3.85	+.7	9	6,698	se.	39	sw.	18	10	8	13	5.8	.0	.0
Milwaukee	681	97	221	29.28	30.02	+.02	69.2	.0	97	9	77	49	25	62	28	61	56	67	1.43	−1.2	9	8,452	e.	35	n.	18	14	9	8	4.5	.0	.0
Duluth	1,133	5	47	28.78	29.98	+.01	61.4	−1.2	92	18	71	38	24	51	35	55	51	73	2.19	−1.0	10	8,117	ne.	59	w.	18	11	10	10	4.9	.0	.0
North Dakota							67.8	+1.8										52	0.97	−1.2										4.2		
Moorhead, Minn	940	50	58	28.96	29.96	.00	67.5	+1.4	95	17	80	39	24	55	37	57	49	58	2.16	−.7	7	6,293	s.	24	n.	18	9	13	9	5.1	.0	.0
Bismarck	1,674	8	57	28.19	29.95	+.01	69.8	+2.5	102	17	83	33	24	56	43	56	45	48	.50	−1.3	3	6,708	nw.	32	nw.	18	14	12	5	4.0	.0	.0
Devils Lake	1,478	11	44	28.41	29.96	+.02	66.1	+1.3	100	17	80	32	24	52	40	54	46	56	1.00	−1.5	6	7,028	se.	30	nw.	1	11	16	4	4.7	.0	.0
Grand Forks	833	12	67				66.6		98	17	81	36	28	52	41	56			1.39		11		nw.	30	nw.	23	4	23	4		.0	.0
Williston	1,878	41	48	28.01	29.95	+.02	68.0	+1.9	101	17	83	35	25	54	44	53	43	47	.21	−1.3	5	6,228	se.	34	w.	17	21	6	4	2.9	.0	.0
Upper Mississippi Valley							73.8	+1.0										67	2.84	−0.4										5.2		
Minneapolis	918	102	208	29.01	29.98		70.1	+.2	97	18	80	42	28	60	30	59	52	59	1.61	−1.5	7	7,635	s.	43	nw.	8	13	9	9	5.1	.0	.0
La Crosse	714	11	48	29.22	29.98	.00	69.4	−.6	94	9	80	40	29	58	34	61	57	72	1.90	−1.8	11	3,297	s.	19	w.	18	11	11	9	4.9	.0	.0
Madison	974	70	78	28.97	30.00	+.01	69.4	−.4	95	9	79	47	30	60	27	62	57	69	2.21	−1.0	10	5,731	se.	21	ne.	27	12	10	9	4.7	.0	.0
Charles City	1,015	10	51	28.93	29.99	+.02	69.0	−.1	97	8	80	38	24	58	36	61	56	69	3.86	+.4	13	4,740	se.	26	ne.	4	12	12	7	4.5	.0	.0
Davenport	606	66	161	29.35	30.00	+.02	73.1	.0	100	9	83	48	29	63	31	64	60	68	5.41	+1.9	10	5,994	ne.	31	nw.	14	8	13	10	5.6	.0	.0
Des Moines	861	5	99	29.07	29.96	−.01	75.8	+2.7	109	8	88	44	25	63	36	63	56	56	1.39	−2.1	7	6,372	n.	30	n.	8	8	14	9	5.3	.0	.0
Dubuque	700	60	79	29.25	29.99	+.01	71.0	−.7	98	8	81	43	29	61	34	62	57	68	3.29	.0	11	3,972	s.	16	n.	9	9	10	12	5.4	.0	.0
Keokuk	614	64	78	29.33	29.99	+.01	77.8	+2.8	110	9	89	50	29	67	32	66	60	60	2.66	−.5	7	5,119	sw.	32	sw.	31	9	10	12	5.6	.0	.0
Cairo	358	87	93	29.62	29.99	.00	79.0	+1.2	99	8	87	56	29	71	27	71	68	75	2.70	−.3	13	5,310	s.	24	sw.	13	6	9	16	6.5	.0	.0
Peoria	609	11	45	29.36	30.02	+.03	74.4	+1.9	104	9	85	48	29	64	36	66	63	74	2.30	−.8	10	4,056	s.	19	ne.	14	13	12	6	4.1	.0	.0
Springfield, Ill	636	5	191	29.32	29.99	.00	77.0	+2.5	108	9	87	48	29	67	29	67	64	71	3.62	+.4	10	7,179	s.	36	n.	2	10	12	9	5.5	.0	.0
St. Louis	568	265	303	29.38	29.98	−.01	80.0	+2.7	108	9	90	52	29	70	29	69	65	66	3.14	+.2	10	7,640	s.	32	sw.	9	10	12	9	5.0	.0	.0
Missouri Valley							79.0	+4.7										53	2.34	−1.0										4.2		
Columbia, Mo	784	6	84	29.15	29.96	−.01	80.1	+4.5	110	10	92	53	29	68	34				4.94	+1.3	7	5,499	sw.	27	nw.	11	9	17	5	4.6	.0	.0
Kansas City	750	32	45	29.15	29.93	−.04	83.0	+6.4	111	10	96	51	24	71	34	67	58	52	1.44	−2.6	10	6,826	sw.	35	sw.	27	13	14	4	4.5	.0	.0
St. Joseph	967	11	49	28.93	29.94		81.0		110	10	94	49	24	68	40	65	57	52	5.84	+2.3	9	5,705	sw.	38	nw.	10	12	15	4	4.1	.0	.0
Springfield, Mo	1,324	98	104	28.60	29.97	.00	80.8	+5.1	104	9	90	56	29	71	29	68	61	59	2.60	−1.5	11	6,848	s.	29	se.	4	14	12	5	4.0	.0	.0
Iola	984	11	50	28.92	29.93	−.03	84.6	+7.5	108	12	99	54	24	70	36				.82	−2.7	6		s.				16	12	3		.0	.0
Topeka	987	65	87				83.6	+7.4	112	10	97	52	24	70	40				1.71	−2.4	8	6,548	s.	27	n.	13	12	15	4	4.0	.0	.0
Lincoln	1,189	11	81	28.70	29.93	−.02	79.0	+4.6	110	8	92	45	25	66	38	63	55	51	2.59	−1.0	7	6,792	ne.	40	n.	12	12	13	6	4.5	.0	.0
Omaha	1,105	170	200	28.80	29.95	−.01	78.6	+4.2	110	5	90	47	24	67	32	63	55	51	1.11	−1.9	11	7,298	s.	35	n.	18	13	12	6	4.4	.0	.0
Valentine	2,598	47	54	27.32	29.99	+.05	73.8	+2.1	107	4	88	43	25	60	38	59	50	50	2.14	.0	8	6,655	n.	35	nw.	30	16	11	4	3.8	.0	.0
Sioux City	1,138	64	106	28.76	29.94	−.01	74.5	+2.5	108	4	87	44	24	62	37	62	55	56	1.12	−2.0	10	6,313	se.	24	se.	29	11	12	8	4.8	.0	.0
Huron	1,306	60	74	28.59	29.96	+.01	72.4	+3.0	110	4	86	40	24	59	38	60	51	54	1.45	−1.0	5	6,918	se.	32	s.	20	18	11	2	3.3	.0	.0
Northern Slope							69.0	+2.7										46	0.77	−0.4										3.9		
Billings	3,140	4																													
Havre	2,505	11	67	27.40	30.00	+.09	67.8	+2.4	102	3	84	40	31	52	43	53	41	46	.98	−.2	8	5,595	e.	39	w.	3	18	12	1	3.0	.0	.0
Helena	4,124	85	111	25.85	29.96	+.02	68.8	+3.8	92	6	83	43	24	55	39	52	40	40	.03	−.7	2	5,959	sw.	35	sw.	17	13	12	6	4.3	.0	.0
Kalispell	2,973	48	56	29.67	29.96	+.06	66.0	+3.2	90	2	82	44	24	50	41	51	38	42	.07	−.8	1	4,754	nw.	25	w.	17	19	12	0	2.6	.0	.0
Miles City	2,371	48	55	27.50	30.00	+.07	72.3	+.8	107	3	86	43	24	59	39	55	42	40	.42	−.7	2	4,883	n.	35	nw.	11	16	10	5	3.6	.0	.0
Rapid City	3,259	50	58	26.67	30.01	+.08	71.7	+2.2	102	3	85	42	23	58	40	57	47	46	.43	−1.3	10	6,233	w.	30	nw.	18	19	7	5	3.5	.0	.0
Cheyenne	6,094	50	71	24.14	29.97	+.05	67.8	+2.2	92	3	81	41	25	54	39	53	45	52	1.41	−.1	9	6,394	nw.	30	nw.	6	10	15	6	5.0	.0	.0
Lander	5,372	60	68	24.75	29.97	+.05	68.6	+3.1	94	3	85	40	24	53	41	53	42	45	.37	−.2	3	4,080	sw.	44	sw.	3	18	9	4	3.5	.0	.0
Sheridan	3,790	10	47	26.16	30.00		67.8		100	17	85	37	25	51	49	53	42	48	.12	−.8	5	3,645	nw.	30	nw.	18	17	7	7	3.8	.0	.0
Yellowstone Park	6,241	11	48	24.03	30.03	+.10	61.	+1.0	86	3	78	36	24	46	43	47	36	48	.68	−.4	5	5,514	sw.	34	sw.	17	14	10	7	4.1	.0	.0
North Platte	2,821	11	51	27.09	29.94	.00	76.1	+5.3	106	5	90	44	25	63	40	62	55	58	3.20	+.8	12	5,239	se.	27	nw.	30	12	15	4	4.6	.0	.0

TABLE 1.—*Climatological data for Weather Bureau stations, August 1934*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max.+mean min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Middle Slope							81.4	+5.5										46	1.68	−0.8										4.6		
Denver	5,292	106	113	24.83	29.97	+0.05	74.4	+3.7	97	3	86	50	25	62	32	57	48	48	.91	−0.5	10	5,726	s.	28	nw.	22	3	26	2	5.1	0.0	0.0
Pueblo	4,685	80	86	25.37	29.93	+.02	77.3	+4.6	100	4	91	50	25	64	35	59	48	45	.40	−1.4	8	5,410	e.	30	w.	18	11	17	3	4.8	.0	.0
Concordia	1,392	50	58	28.51	29.94	−.01	82.5	+6.0	109	8	95	51	24	70	35	65	54	45	.71	−2.2	7	6,084	sw.	24	ne.	23	12	16	3	4.5	.0	.0
Dodge City	2,509	10	86	27.40	29.93	.00	82.8	+5.1	105	9	96	52	24	70	34	64	54	45	.24	−2.4	7	8,958	s.	33	se.	27	17	10	4	3.6	.0	.0
Wichita	1,358	85	93	28.52	29.90	−.05	85.3	+7.0	106	1	96	57	24	74	34	66	56	43	.38	−2.8	6	8,034	sw.	30	w.	1	14	11	6	4.4	.0	.0
Oklahoma City	1,214	10	47	28.69	29.94	.00	86.2	+6.5	107	12	97	59	25	75	28	69	61	51	7.44	+4.6	5	6,630	s.	22	sw.	2	11	11	9	5.0	.0	.0
Southern Slope							83.6	+4.0										51	0.81	−1.5										3.4		
Abilene	1,738	10	52	28.18	29.92	.00	86.6	+4.6	104	13	98	63	25	75	28	69	61	50	.15	−2.1	2	7,137	s.	22	s.	3	17	9	5	3.3	.0	.0
Amarillo	3,676	10	49	26.32	29.93	+.01	81.4	+5.7	104	1	93	57	25	70	30	64	55	48	1.51	−1.6	5	6,693	s.	22	se.	30	15	10	6	4.4	.0	.0
Big Spring	2,537	5	62	27.38	29.93	------	82.8	------	100	13	94	62	25	72	30	67	59	52	3.41	------	3	------	s.	------	------	------	19	9	3	3.5	.0	.0
Del Rio	944	64	71	28.92	29.88	−.02	86.0	+1.8	99	22	95	74	2	77	22	72	65	56	.10	−1.6	1	7,889	se.	23	se.	10	16	13	2	3.3	.0	.0
Roswell	3,566	75	85	26.39	29.90	+.02	80.4	+3.8	101	1	93	59	24	68	31	64	54	50	1.48	−.7	6	5,727	se.	34	n.w	22	23	6	2	2.4	.0	.0
Southern Plateau							80.0	+2.6										52	1.18	0.0										4.1		
El Paso	3,778	152	175	26.18	29.84	.00	83.8	+4.6	101	1	95	67	30	72	28	65	55	43	.60	−1.1	8	7,086	e.	34	sw.	21	26	4	1	2.2	.0	.0
Albuquerque	4,972	5	39	25.10	29.84	------	77.2	------	101	1	91	57	23	64	37	60	51	50	2.10	+.9	8	6,067	n.	34	se.	16	10	16	5	4.9	.0	.0
Santa Fe	7,013	38	53	23.40	29.90	+.01	70.2	+2.8	90	1	82	51	23	59	31	55	47	52	2.35	+.1	17	4,320	e.	16	nw.	22	4	20	7	5.8	.0	.0
Flagstaff	6,907	10	59	23.48	29.92	+.08	65.4	+2.6	89	2	79	46	31	52	34	54	----	72	4.56	------	21	5,208	n.	30	nw.	10	0	16	15	----	.0	.0
Phoenix	1,108	10	107	28.70	29.81	+.02	90.0	+1.5	113	1	101	71	4	79	28	71	62	46	1.07	+.1	7	4,707	w.	34	s.	3	9	19	3	5.0	.0	.0
Yuma	141	9	54	29.66	29.80	+.04	91.8	+1.4	113	1	104	72	4	79	35	75	68	51	.74	+.2	2	4,397	s.	23	se.	27	23	7	1	2.4	.0	.0
Independence	3,957	5	26	25.98	29.93	+.12	79.0	+2.9	103	18	96	52	7	62	45	57	----	----	.21	+.1	2	------	se.	----	------	----	21	9	1	----	.0	.0
Middle Plateau							75.0	+3.9										35	0.89	+0.2										3.6		
Reno	4,527	61	76	25.51	29.91	+.07	73.3	+6.3	97	18	91	49	28	55	47	52	36	32	.19	.0	1	4,906	w.	30	w.	27	23	7	1	1.6	.0	.0
Tonopah	6,090	12	20	------	------	------	75.1	------	93	18	86	55	27	64	31	54	38	30	.36	------	4	------	se.	------	------	------	------	------	------	------	.0	.0
Winnemucca	4,344	18	56	------	29.94	+.06	73.4	+4.1	99	25	94	45	23	53	51	----	----	24	.01	−.2	1	5,339	ne.	21	sw.	27	25	4	2	----	.0	.0
Modena	5,473	10	46	24.68	29.90	+.04	72.1	+2.9	93	1	87	54	30	58	37	56	46	51	1.81	+.5	12	7,151	sw.	31	ne.	21	5	19	7	5.7	.0	.0
Salt Lake City	4,360	86	210	25.64	29.91	.00	77.8	+3.3	100	2	90	58	31	65	33	58	43	34	1.01	+.2	7	5,401	s.	27	ne.	8	21	5	5	3.3	.0	.0
Grand Junction	4,602	60	68	25.42	29.92	+.02	78.3	+2.9	100	2	92	56	23	65	35	59	48	41	1.45	+.3	6	4,886	se.	33	s.	9	13	15	3	4.0	.0	.0
Northern Plateau							72.9	+3.6										35	0.20	−0.2										2.3		
Baker	3,471	48	53	26.48	30.00	+.05	68.2	+3.6	96	16	86	43	4	50	43	51	37	37	.01	−.5	1	4,977	n.	16	n.	17	23	6	2	2.4	.0	.0
Boise	2,739	79	87	27.14	29.93	.00	74.9	+3.1	100	16	91	52	4	59	39	55	39	32	.10	−.1	1	3,856	nw.	23	nw.	30	21	8	2	2.3	.0	.0
Pocatello	4,477	60	68	25.52	29.92	.00	73.2	+3.6	95	17	89	49	24	58	42	53	36	33	.37	−.3	3	5,927	se.	27	s.	8	19	9	3	3.1	.0	.0
Spokane	1,929	101	110	27.96	29.97	+.02	71.0	+2.9	96	28	86	48	4	56	39	53	39	37	.19	−.4	2	3,881	s.	20	s.	17	26	2	3	2.1	.0	.0
Walla Walla	991	57	65	28.90	29.95	−.01	75.8	+3.1	100	26	90	51	4	62	37	57	41	33	.35	−.1	1	3,919	s.	17	sw.	17	27	3	1	1.4	.0	.0
Yakima	1,076	58	67	28.85	29.98	------	74.5	+5.0	98	26	89	50	4	60	38	57	44	39	.20	.0	2	4,834	nw.	20	nw.	17	23	5	3	2.3	.0	.0
North Pacific Coast Region							64.1	+2.0										68	0.84	0.0										5.0		
North Head	211	11	56	29.88	30.10	+.07	58.7	+1.1	76	22	62	51	23	56	20	56	55	90	1.02	.0	11	9,191	n.	38	s.	5	3	5	23	8.2	.0	.0
Seattle	125	90	321	29.93	30.06	+.06	66.2	+3.1	88	25	76	52	31	57	30	58	52	66	.18	−.5	4	5,194	n.	30	w.	5	12	12	7	4.3	.0	.0
Tatoosh Island	86	10	54	29.99	30.09	+.09	56.2	+.9	68	22	59	49	8	53	15	54	53	92	3.41	+1.4	11	7,263	s.	24	s.	5	2	4	25	8.7	.0	.0
Medford	1,329	29	58	28.57	29.94	------	74.0	------	103	26	92	47	4	56	46	57	45	43	.02	−.2	1	5,010	nw.	42	se.	27	23	7	1	1.8	.0	.0
Portland, Oreg	153	68	106	29.88	30.04	+.03	69.5	+2.8	95	22	80	53	4	58	34	61	55	64	.33	−.3	3	4,654	nw.	21	15	10	6	4.3	.0	.0
Roseburg	510	45	76	29.48	30.02	+.02	70.0	+2.0	101	22	86	46	4	54	45	58	49	56	.09	−.2	1	3,897	n.	16	ne.	19	18	10	3	2.6	.0	.0
Middle Pacific Coast Region							68.9	+2.0										64	T	−0.1										3.6		
Eureka	62	73	89	29.90	30.06	+.06	57.0	+1.0	71	5	61	49	21	53	18	55	53	89	.01	−.2	1	4,680	n.	21	n.	6	4	9	18	7.3	.0	.0
Red Bluff	330	5	58	29.53	29.87	+.01	82.3	+2.6	108	18	99	59	10	66	40	62	47	34	T	.0	0	3,994	s.	15	nw.	18	28	0	3	1.1	.0	.0
Sacramento	66	92	115	29.82	29.89	+.04	75.4	+2.5	105	18	93	51	10	58	44	61	51	52	T	.0	0	6,090	s.	18	s.	25	29	2	0	.8	.0	.0
San Francisco	155	208	243	29.80	29.97	+.05	60.9	+1.8	88	18	67	51	10	54	30	56	53	82	T	.0	0	5,822	sw.	28	w.	2	6	14	11	5.5	.0	.0
South Pacific Coast Region							73.7	+0.2										64	0.01	0.0										3.3		
Fresno	327	97	105	29.53	29.87	+.05	81.0	+.3	106	18	98	58	15	64	39	61	45	35	.00	.0	0	5,110	nw.	16	nw.	8	25	5	1	1.5	.0	.0
Los Angeles	338	159	191	29.58	29.94	+.06	71.1	.0	88	18	80	59	31	62	24	63	60	75	.01	.0	1	3,987	sw.	13	sw.	6	16	14	1	3.4	.0	.0
San Diego	87	62	70	29.84	29.93	+.04	69.0	+.3	79	19	73	62	29	65	15	64	62	82	.02	.0	1	5,064	w.	15	w.	12	12	13	6	4.9	.0	.0
West Indies																																
San Juan, P. R	82	9	54	29.93	30.02	------	80.2	−.3	90	28	85	72	25	76	14	----	----	----	6.72	+.7	22	9,214	e.	29	e.	24	2	23	6	5.6	.0	.0
Panama Canal																																
Balboa Heights	118	6	97	------	[1] 29.85	+.02	80.6	−.6	9	[1]8	87	72	26	74	16	76	75	[1] 86	4.52	−3.3	18	4,159	nw.	22	nw.	10	0	16	15	7.5	.0	.0
Cristobal	36	6	97	------	[1] 29.86	+.02	81.8	+1.6	[1].	[1]7	87	73	1	77	16	76	76	[1] 84	13.86	−1.4	25	5,527	n.	24	nw.	9	0	9	22	8.6	.0	.0
Alaska																																
Fairbanks	454	11	87	[2] 29.46	[2] 29.97	------	55.5	----	7	5	65	36	22	46	35	49	44	68	3.35	------	17	4,336	s.	23	n.	3	2	3	26	8.6	.0	.0
Juneau	80	96	116	[2] 30.03	[2] 30.12	------	55.9	--	0	6	61	44	30	51	22	53	51	84	7.77	------	24	3,628	s.	29	se.	1	0	5	26	9.0	.0	.0
Hawaiian Islands																																
Honolulu	38	86	100	[2] 29.97	[2] 30.01	------	79.6	------	87	28	84	72	25	75	13	72	69	73	.94	−.3	8	6,289	e.	24	ne.	3	9	15	7	5.0	.0	.0

[1] Observations taken hourly.
[2] Pressure not reduced to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian Meteorological Service, August 1934*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*In.*	*In.*	*In.*
Cape Race, Newfoundland	99				56.2		63.0	49.3	68	40	5.99		0.0
Sydney, Cape Breton Island	48	29.92	29.97	+0.02	65.6	+2.3	75.6	55.7	83	48	1.44	−2.18	.0
Halifax, Nova Scotia	88	29.76	29.86	−.10	63.9	+.3	71.3	56.5	78	49	1.65	−2.70	.0
Yarmouth, Nova Scotia	65	29.90	29.97	.00	60.6	+.4	69.0	52.1	76	44	.99	−2.63	.0
Charlottetown, Prince Edward Island	38	29.80	29.84	−.10	65.1	+.8	72.2	58.0	79	51	4.55	+.81	.0
Chatham, New Brunswick	28	29.83	29.86	−.07	61.3	−1.9	71.6	50.9	85	38	4.31	+.27	.0
Father Point, Quebec	20	29.87	29.89	−.02	55.9	+.3	63.9	48.0	80	39	2.14	−.91	.0
Quebec, Quebec	296	29.66	29.98	+.05	62.2	−.9	70.4	53.9	82	44	4.73	+.90	.0
Doucet, Quebec	1,236				53.4		66.1	40.7	83	26	4.57		.0
Montreal, Quebec	187												
Ottawa, Ontario	236	29.74	30.00	+.04	64.9	+.1	76.2	53.6	90	42	1.22	−1.81	.0
Kingston, Ontario	285	29.70	30.00	+.02	65.3	−1.7	73.6	57.0	85	44	1.26	−1.12	.0
Toronto, Ontario	379	29.62	30.01	+.02	65.5	−.5	75.5	55.5	89	45	1.01	−1.75	.0
Cochrane, Ontario	930				56.1		66.4	45.9	85	34	2.39		.0
White River, Ontario	1,244	28.67	29.97	+.01	54.1	−2.3	69.3	38.9	86	24	2.01	−1.29	.0
London, Ontario	808				63.9		75.7	52.2	89	34	2.95		.0
Southampton, Ontario	656												
Parry Sound, Ontario	688	29.32	30.00	+.02	62.8	−.7	72.7	52.8	89	38	2.00	−.72	.0
Port Arthur, Ontario	644	29.26	29.97	+.01	59.1	−.4	68.4	49.8	87	36	2.72	−.03	.0
Winnipeg, Manitoba	760	29.13	29.95	+.01	62.4	−1.0	73.7	51.0	92	34	3.28	+.61	.0
Minnedosa, Manitoba	1,690	28.17	29.96	+.02	60.2	+.8	73.7	46.6	92	32	1.55	−.55	.0
Le Pas, Manitoba	860				58.0		67.9	48.2	82	35	1.80		.0
Qu'Appelle, Saskatchewan	2,115	27.72	29.94	+.01	60.9	−.6	76.2	45.6	95	27	1.26	−.38	.0
Moose Jaw, Saskatchewan	1,759				63.7		78.9	48.5	98	30	1.11		.0
Swift Current, Saskatchewan	2,392	27.45	29.94	+.01	63.6	−.4	80.1	47.1	99	29	.47	−1.44	.0
Medicine Hat, Alberta	2,365	27.48	29.92	.00	66.9	+1.2	81.2	52.6	99	36	.87	−.80	.0
Calgary, Alberta	3,540	26.36	29.98	+.07	60.6	+1.2	74.7	46.5	90	37	1.38	−.76	.0
Banff, Alberta	4,521	25.52	30.03	+.12	58.1	+1.8	75.1	41.1	85	32	.35	−2.18	.0
Prince Albert, Saskatchewan	1,450	28.45	30.01	+.09	59.8	+.9	71.7	47.9	90	30	.76	−1.39	.0
Battleford, Saskatchewan	1,592	28.27	29.99	+.08	60.6	−2.0	74.7	46.4	94	29	7.05	+4.69	T
Edmonton, Alberta	2,150	27.74	29.99	+.07	58.4	−.4	71.3	45.5	88	28	1.72	−.41	.0
Kamloops, British Columbia	1,262	28.75	30.02	+.11	68.7	+.1	84.4	53.1	99	46	.27	−.82	.0
Victoria, British Columbia	230	29.81	30.06	+.05	60.5	+1.8	67.9	53.1	81	50	.65	+.05	.0
Barkerville, British Columbia	4,180												
Estevan Point, British Columbia	20				58.6		64.2	53.0	74	49	6.20		.0
Prince Rupert, British Columbia	170				57.5		64.5	50.4	71	44	2.89		.0
St. Georges, Bermuda	151	30.00	30.16	+.06	80.3	+.7	85.8	74.9	88	70	8.74	+2.66	.0

LATE REPORTS FOR JULY 1934

Cape Race, Newfoundland	99												
Sydney, Cape Breton Island	48												
Halifax, Nova Scotia	88												
Yarmouth, Nova Scotia	65												
Charlottetown, Prince Edward Island	38												
Chatham, New Brunswick	28												
Father Point, Quebec	20												
Quebec, Quebec	296												
Doucet, Quebec	1,236												
Montreal, Quebec	187												
Ottawa, Ontario	236												
Kingston, Ontario	285												
Toronto, Ontario	379												
Cochrane, Ontario	930												
White River, Ontario	1,244												
London, Ontario	808												
Southampton, Ontario	656												
Parry Sound, Ontario	688												
Port Arthur, Ontario	644												
Winnipeg, Manitoba	760	29.11	29.92	−.01	66.0	.0	78.9	53.2	92	40	1.77	−1.31	.0
Minnedosa, Manitoba	1,690												
Le Pas, Manitoba	860												
Qu'Appelle, Saskatchewan	2,115												
Moose Jaw, Saskatchewan	1,759												
Swift Current, Saskatchewan	2,392												
Medicine Hat, Alberta	2,365												
Calgary, Alberta	3,540	26.28	29.89	−.01	61.3	+.7	75.3	47.3	94	36	2.22	−.46	.0
Banff, Alberta	4,521												
Prince Albert, Saskatchewan	1,450	28.37	29.92	+.01	63.6	+1.7	74.9	52.3	91	39	1.38	−.67	.0
Battleford, Saskatchewan	1,592												
Edmonton, Alberta	2,150	27.64	29.88	−.02	59.8	−.8	71.2	48.4	90	38	2.97	−.06	.0
Kamloops, British Columbia	1,262	28.67	29.93	−.01	69.3	+.8	83.8	54.8	104	42	.94	−.67	.0
Victoria, British Columbia	230												
Barkerville, British Columbia	4,180												
Estevan Point, British Columbia	20				56.4		62.1	50.6	71	45	5.84		.0
Prince Rupert, British Columbia	170				55.3		60.9	49.6	86	42	4.11		.0
St. Georges, Bermuda	151	30.00	30.16	+.02	78.9	+.2	84.6	73.3	91	70	9.03	+4.59	.0

SEVERE LOCAL STORMS, AUGUST 1934

[Compiled by Mary O. Souder]

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Broken Bow, Nebr.	1	7:20 p. m.	[1] 5		$5,000	Wind and hail	No details	Official, U. S. Weather Bureau.
Merrill, Wis., vicinity of	1				25,000	Heavy hail	Considerable damage to growing crops, especially grain; property loss, $25,000.	Do.
Brown, Kewaunee, and Manitowoc Counties, Wis.	2	9 a. m.			25,000	do	Hailstones as large as golf balls in vicinity of Green Bay and West de Pere; windows broken; glass in greenhouses smashed; automobile tops punctured; roofs damaged; crop loss not estimated.	Do.
Cleveland, Ohio	2	10:02 a. m.-7:10 p. m.		2		Thundersquall	Many trees uprooted; wires and cables blown down; 2 persons drowned while fishing; 3 others missing.	Do.
Orangeburg County, S. C.	2	2 p. m.	1,320		1,500	Hail	Crop loss, $1,000; damage to buildings and pecan groves, $500.	Do.
Flint and southeastern Michigan.	2	4 p. m.		11	2,000,000	Wind, rain, and hail.	Flint section hardest hit; 15 minutes after storm began cars were stalled without power and automobiles were disabled; factories were idle and dark; communication impossible for hours; path 100 miles long.	Do.
Madonna, Md.	2	6 p. m.	100			Tornado	Dwelling and outbuildings wrecked; 10 acres of corn badly damaged; path 1½ miles long.	Do.
Toledo, Ohio, and vicinity	2	6:10-6:16 p. m.				Thunderstorm and hail.	Damage mostly to growing crops; amount not estimated.	Do.
Hickory Point, Md.	2	10 a. m.	17			Waterspout and tornado.	8 persons injured and 10 houses wrecked along the water front; at least 20 small boats were sunk or blown ashore, some rowboats and canoes being lifted 50 feet in the air and wrecked against trees; trees uprooted.	Do.
Dunkirk, N. Y., south of	2				2,500	Electrical	2 barns burned after being struck by lightning	Do.
Hamburg, N. Y.	2				3,000	do	Barn and 2 sheds struck by lightning and burned	Do.
Astoria, Ill.	2				15,000	Wind	Property damaged; path 2 miles long	Do.
Danville, Ill.	2					do	Trees blown down; electric service interrupted	Do.
Litchfield, Ill.	2		[1] 1-3		63,000	Wind and hail	Property damage, $60,000; crop loss, $3,000	Do.
Rosamond, Ill.	2		[1] 1		5,000	Wind	$5,000 property damage; considerable loss to corn crop; path 5 miles long.	Do.
Royal, Ill.	2				1,000	Hail	Property damage $1,000; considerable loss in corn crop; path 8 miles long.	Do.
Sangamon County, Ill., southeast portion.	2				16,700	Wind	Property damage	Do.
Tallula, Ill., and vicinity	2				10,000	do	Property loss $10,000; extensive damage to corn; path 20 miles long.	Do.
Thayer (near), Ill.	2				600	Hail	Loss to crops; path 1½ miles long	Do.
Vermilion County, Ill., central portion.	2		[1] 4		4,000	Wind	Property damaged over a path 15 miles long	Do.
Waverly (near), Ill.	2					Hail	Considerable loss to crops and property; path 15 miles long.	Do.
St. Joseph County, Ind.	2			1	7,000	Wind	Damage mostly to buildings; loss to crops; woman drowned in Juno Lake when her boat was upset by the storm.	Do.
St. Joseph County, Ind.	2		[1] 2		50,000	Severe hail	This storm occurred about one-half hour after the storm mentioned above. Hail fell to a depth of 2 to 3 inches and destroyed 75 to 90 percent of crops; roofs of buildings damaged; path 12 miles long.	Do.
Versailles, Mo.	2					Wind	Silos, barns, trees, and telephone poles blown down; porches torn from several houses; damage not estimated.	Do.
Lindale, Md.	3	12:30 a. m.			3,000	Tornado	Dwelling with contents and outbuildings demolished; silo blown down; family of 4 injured; much corn and other crops leveled.	Do.
Coffeyville to Cherryvale and Dennis, Kans.	3	6-7 p. m.	[1] 2			Wind, electrical	Old Mill Building demolished with damage of $8,000; hundreds of telephone and power line poles blown down; amount of damage not estimated; house and barn near Mound Valley struck by lightning and burned.	Do.
Choteau, Agawam, and Farmington, Mont.	3	7 p. m.	[1] ½-3		100,000	Hail	No details	Do.
Anderson, S. C.	4	6:30 p. m.	[1] 2		10,000	Thunderstorm	Property damage $9,000; crop loss $1,000	Do.
Macon and Thomaston, Ga.	4			2		Electrical	In Thomaston, 15 miles west of Macon, woman was killed about 3 p. m. while hoeing in a flower garden; in Macon man killed by lightning preceding a severe thunderstorm at 5:30 p. m.	Do.
Hopkins, Mo., west of	4		[1] 2			Heavy hail	Foliage of trees, shrubs and corn cut off and shingle roofs badly damaged; path 10 miles long; loss not estimated.	Do.
Atlanta, Ga.	4-5					Thunderstorm and hail.	6 homes struck by lightning	Do.
Hennepin County, Minn.	8	5 p. m.				Thundersquall and heavy rain.	Trees uprooted; overhead wire systems disrupted; buildings unroofed or otherwise damaged; small damage from lightning.	Do.
Putnam County, Tenn.	8	5:45 p. m.				Wind and hail	Trees down; windows broken; gardens and growing fields damaged.	Do.
Pittsburgh, Pa.	9	A. m.			150,000	Electrical, heavy rain.	Large mattress factory destroyed; much damage from flooding.	Do.
Butler, Pa.	9	2:30-8 a. m.			25,000	Heavy rain	Damage from flooding; interruption of transit and communication facilities.	Do.
Belcher-Hosston, La.	9	1-2 p. m.	[1] 10		9,300	Thundersquall	Small houses blown down; property damage $3,300; loss to crops $5,000, and to timber $1,000; minor damage to wires; path 10 miles long.	Do.
Morrison and Starbuck, Colo., and vicinity.	9	2 p. m.	[1] 6	6		Heavy rain and hail.	A wall of water which swept Bear Creek Canyon as a result of heavy rain in O'Brien and Sawmill Gulches, damaged bridges and highways and caused the death of 6 persons; amount of damage not estimated; hail damage negligible.	Do.

[1] Miles instead of yards.

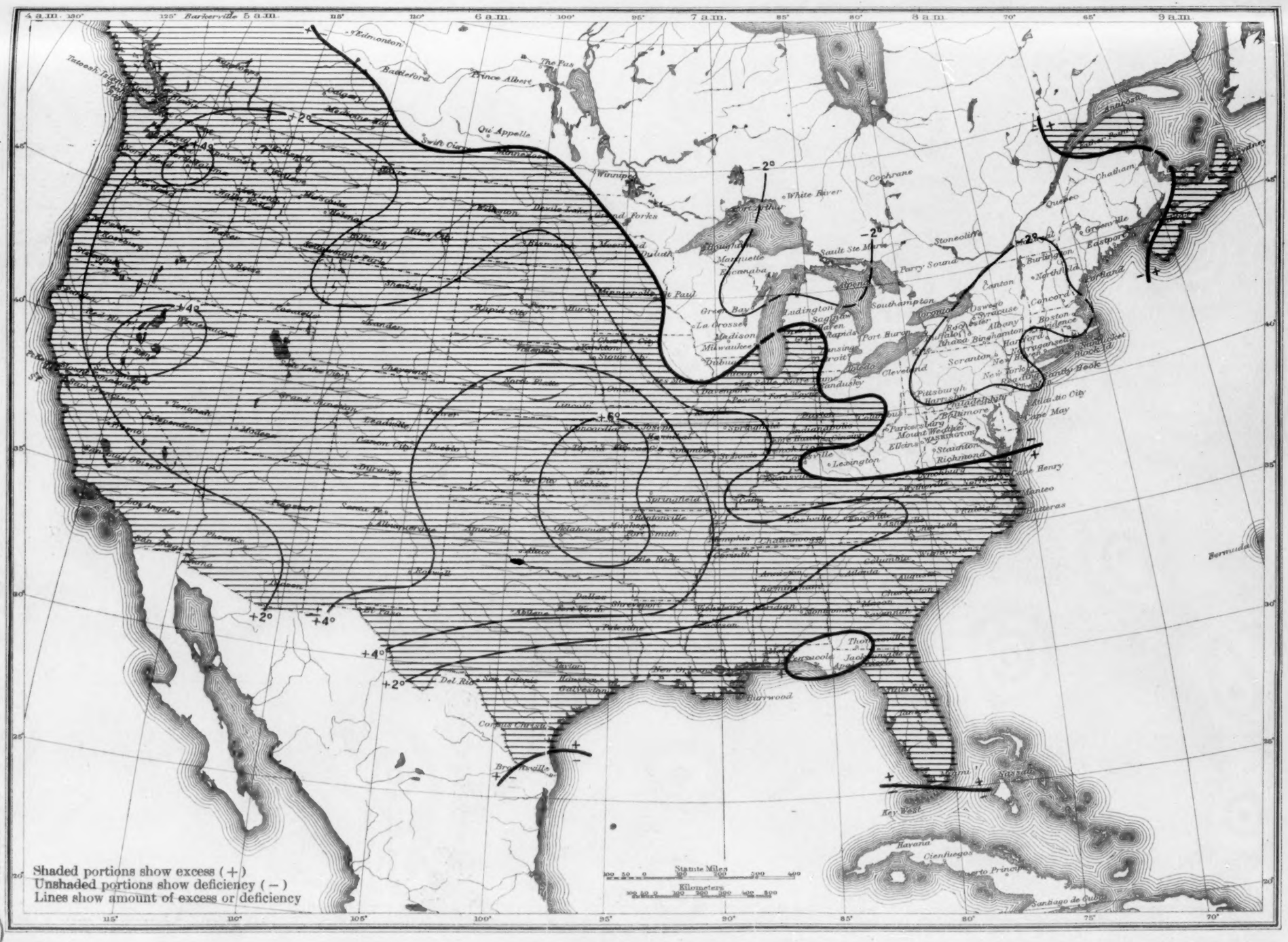
SEVERE LOCAL STORMS, AUGUST 1934—Continued

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Timberville and Broadway, Va., and vicinity.	9	3–5 p. m.	[1] ½–2		260,000	Hail	Affected district grows fruit extensively; $250,000 loss to crops, mostly apples and peaches; property damage $10,000.	Official, U. S. Weather Bureau.
Ashdown, Ark.	9				10,000	Wind	2 persons injured; property damaged.	Do.
Glenwood, Ark., and vicinity.	9				10,000	do	Houses unroofed; windows broken.	Do.
Highland County, Ohio.	9–10				12,500	Wind and heavy hail.	Damage to crops, buildings, trees, land, etc.; total damage over the State during this period $100,000.	Do.
Merriman, Kans., and vicinity.	11	5:30 p. m.				Tornado	On the Van estate chicken house demolished; one side of barn was carried away and the structure moved on its foundation; 50 cherry trees uprooted; on Mission Hill Acres several small buildings damaged; shed demolished and lawn furniture destroyed.	Do.
Bancroft, Kans., and vicinity.	11	P. m.				Wind, rain, and hail.	Several barns blown down or wrecked; concrete bridge south of Bancroft washed out by flood waters; several inches of rain fell in short time; parts of corrugated iron roof of barn demolished by wind and scattered for nearly a mile; much damage to young orchard; large barn and contents struck by lightning and burned.	Do.
Dodge City, Kans.	11	do				Electrical	Man injured by lightning while driving his car.	Do.
Jacksonville, Ill.	11				5,000	Wind	Property damaged.	Do.
Olney, Ill.	11				900	Electrical	Barn burned.	Do.
Hamburg and Dunkirk, N. Y.	11				5,500	Thunderstorm	In Hamburg, barn and 2 sheds struck by lightning and burned; 2 barns south of Dunkirk burned; ferryboat on Lake Chautauqua grounded.	Do.
Boelus, Nebr.	12	5–6 p. m.	[1] 4		10,000	Hail	Large hailstones; no details.	Do.
Springranch, Nebr.	12	6:45 p. m.	[1] 2½		10,000	Hail	Hailstones from the size of marbles to hen eggs.	Do.
St. Louis and Callaway Counties, Mo.	12				5,000	Wind	Property damaged; trees broken.	Do.
Nemaha, Jackson, Atchison, and Jefferson Counties, Kans.	12–13	11 p. m.–1 a. m.	[1] 10		30,000	Wind and hail	Many barns, silos and small buildings blown down; fruit trees damaged; hail 6 inches deep in Jackson County; path 25 miles long.	Do.
Arcadia, Nebr.	13	7–8 p. m.	[1] 1		4,000	Hail	No details.	Do.
Buffalo, N. Y.	13				2,500	Thunderstorm	House struck by lightning and burned.	Do.
Athboy, S. Dak.	13					Tornado	Small damage reported.	Do.
Sutherland, Nebr.	16	8:35–9 p. m.	433		20,000	do	1 person injured; considerable property damaged; trees uprooted; basements flooded.	Do.
Akron (near), Colo.	16	P. m.	[1] 1		8,000	Wind	House and barn damaged.	Do.
Milbank, S. Dak.	16				35,000	Electrical	Dakota Granite Works with all equipment and 4 carloads of finished products destroyed with loss of $30,000; barn struck by lightning and burned.	Do.
Hazen (near), Ark.	17				500	Heavy rain	Loss to rice crop.	Do.
St. Croix County, Wis.	18	6 a. m.	¼		30,000	Thundersquall	Barns, silos and buildings demolished or damaged; trees uprooted; path 15 miles long.	Do.
Minnesota, almost entire State.	18	2:30–8:30 p. m.		3	1,271,000	Thundersquall and hail.	3 persons injured; damage from wind $100,000 to crops and $611,000 to property; hailstones remained on the ground for 24 hours causing damage of $560,000; poultry, small stock and wild game perished. This storm one of the most severe in this State.	Do.
Minnesota to west-central counties northeastward in Wisconsin.	18	7:30–9 p. m.		1	700,000	Tornadic winds	Loss heavy in Pepin, Buffalo, Trempealeau, and La Crosse Counties in the west-central portion of the State and in Marathon, Langlade, and Shawano in the northeastern; $200,000 damage in city of Wausau alone; man killed when the wind overturned his wagon.	Do.
South Dakota, entire State.	18	8–10 p. m.				Dust storm	High winds caused severe dust storm with greatly reduced visibility; practically all cooperative observers commented on this storm.	Do.
Akron, Colo., south of.	18	P. m.				Tornado	Roof and walls of 3 rooms of farmhouse carried away, occupants uninjured; barn destroyed, automobile inside slightly damaged; 3 small buildings blown away and no trace of them found.	Do.
Platte City and Weston, Mo., and vicinity.	18		880		37,000	Wind	In Platte City 25 barns and other farm buildings destroyed; in Weston property loss $35,000 and damage to an orchard $2,000; 2 persons injured.	Do.
Westcliffe, Colo.	19	P. m.			12,000	Electrical and hail.	7 horses killed by lightning; considerable loss to crops.	Do.
Aberdeen (near), Miss.	19–20	do				Electrical	Barn containing 80 tons of hay burned after being struck by lightning.	Do.
Rifle, Colo.	20	do			500	Flood	Flood in Rifle Creek caused loss to crops and property damage.	Do.
Ford (near), Kans.	20					Wind and rain	Large barn demolished.	Do.
South Fork, Colo.	21	P. m.		1		Flood	Heavy rain resulted in the death of a man when his automobile was carried off a narrow bridge by a wall of water.	Do.
Memphis, Tenn., eastern section.	22	do			6,000	Rain	Water several feet deep in streets; basements flooded; cars stalled.	Do.
Scott City, Kans., south of.	22		[1] 5		2,500	Wind	Large barn and smaller buildings blown down; oil rig damaged; path 10 miles long.	Do.
Manitou, Okla.	22		[1] 1		5,000	Hail	Damage to growing crops; path 5 miles long.	Do.
Jeannette, Pa.	22			2		Electrical	Man and boy killed when a lightning bolt struck a tree; no property damage.	Do.
Memphis, Tenn.	23	P. m.				do	Lightning struck a street car on Main Street; none of 13 passengers injured, fire department extinguished the blaze; man standing near window in his home injured by lightning.	Do.
Chattanooga, Tenn.	25	4:15–5:30 p. m.				Thunderstorm and excessive rain.	2.12 inches of rain fell; basements in business section flooded; cars stranded; telephone and electric service interrupted; amount of damage not estimated.	Do.
San Francisco, Calif.	26					Thunderstorm	Chimney of house struck by lightning; man shocked while working on his radio aerial.	Do.
Globe-Miami, Ariz.	27			2	20,000	Electrical, rain and flood.	Stores and homes damaged; woman drowned when the car in which she was riding became stalled in flood waters; lightning killed a man at Flagstaff and set fire to a building.	Do.

[1] Miles instead of yards.

Chart I. Departure (°F.) of the Mean Temperature from the Normal, August 1934

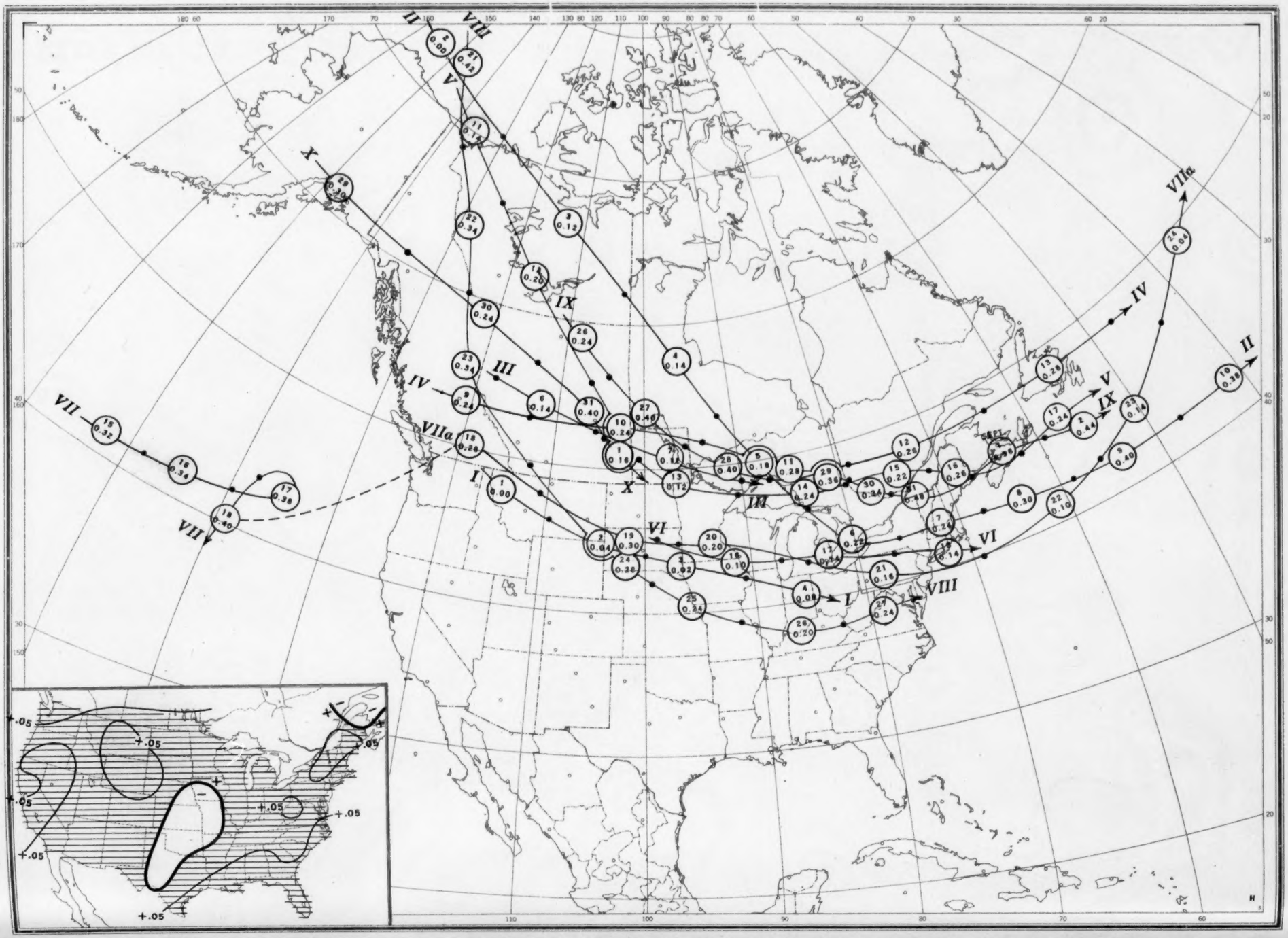
Chart I. Departure (°F.) of the Mean Temperature from the Normal, August 1934



UNIV. OF MICH.

Chart II. Tracks of Centers of Anticyclones, August 1934. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by G. E. Dunn)



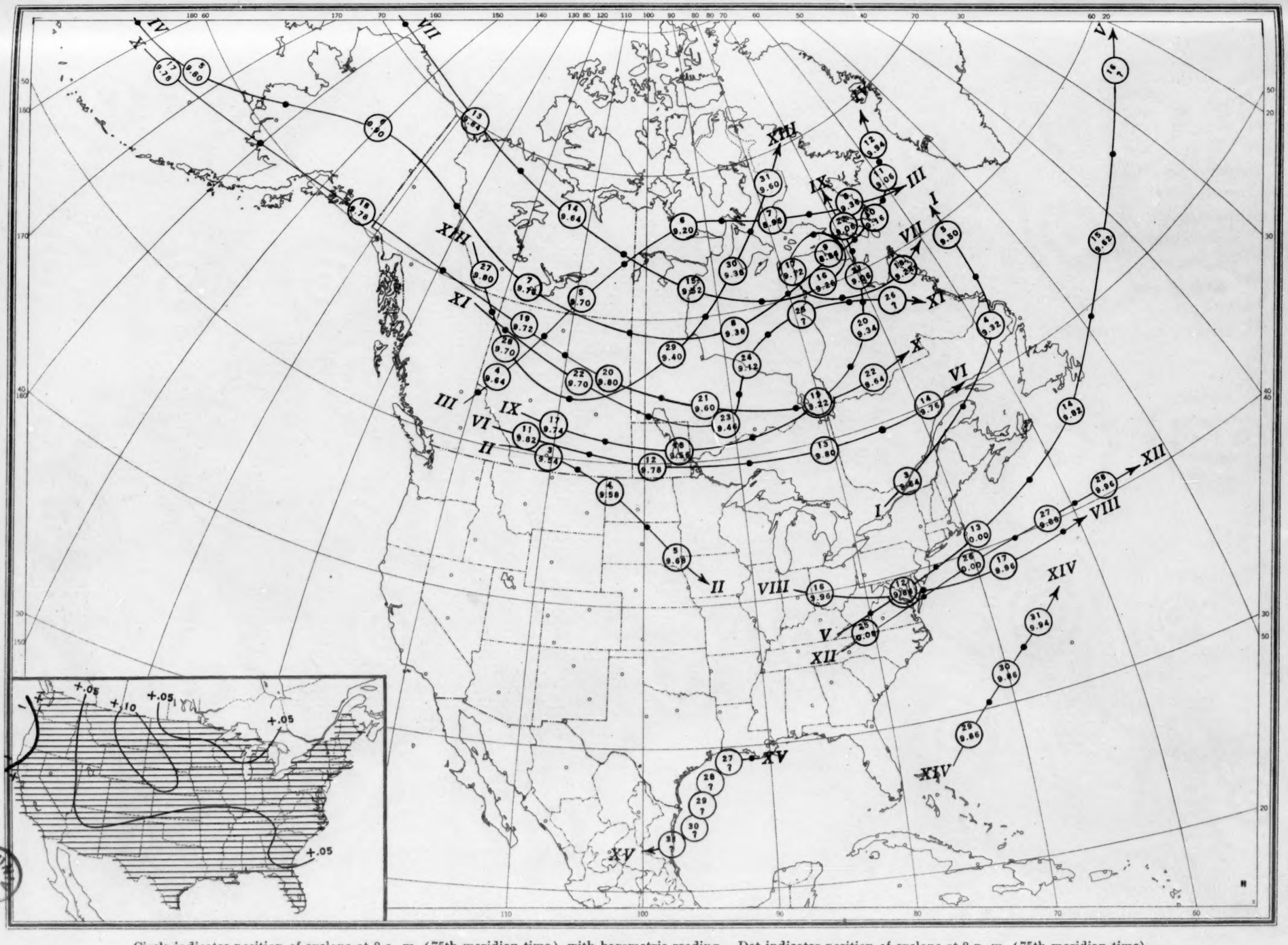
Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, August 1934. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by G. E. Dunn)

Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, August 1934. (Inset) Change in Mean Pressure from Preceding Month
(Plotted by G. E. Dunn)



Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky between Sunrise and Sunset, August 1934

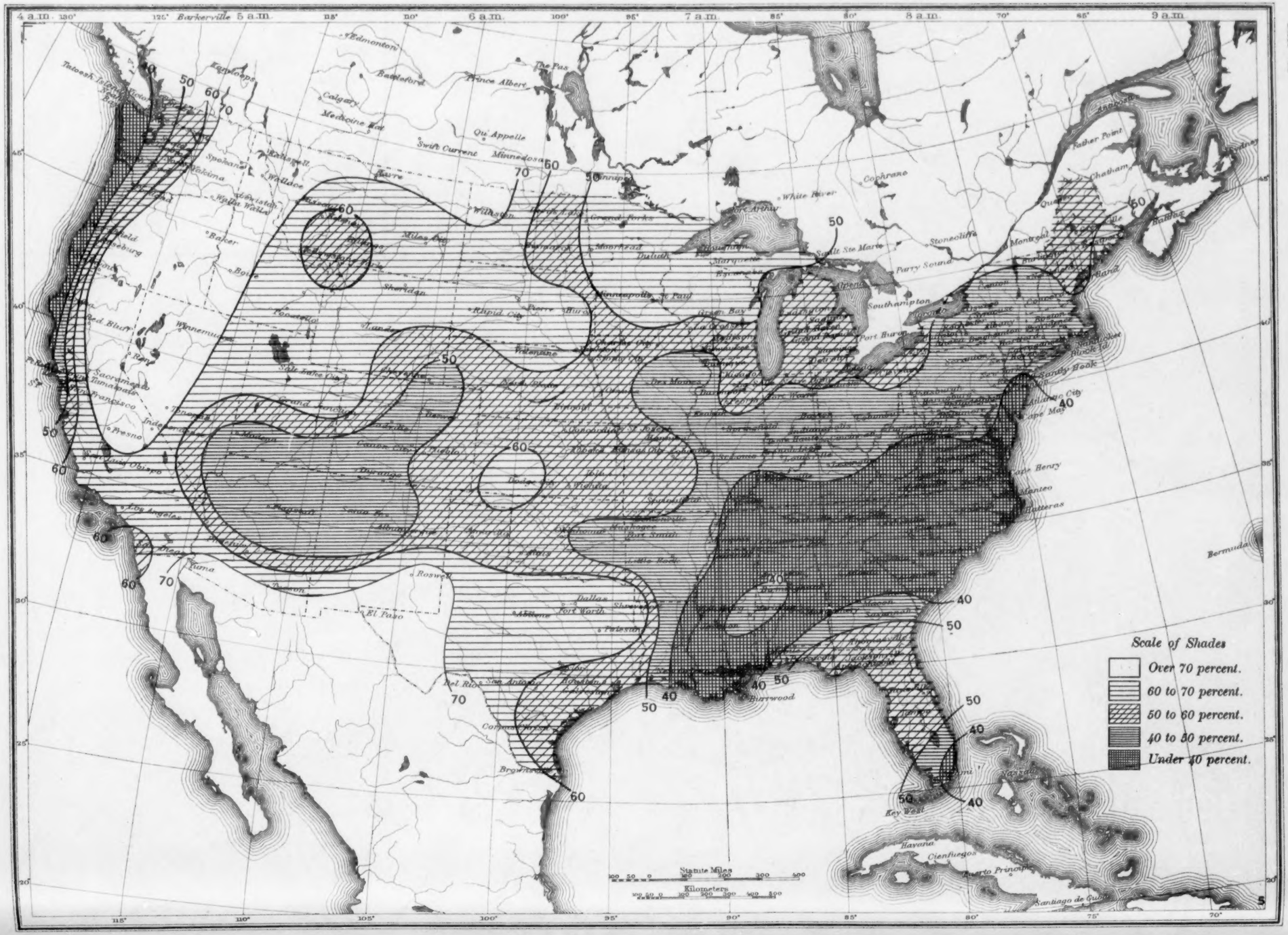


Chart V. Total Precipitation, Inches, August 1934. (Inset) Departure of Precipitation from Normal

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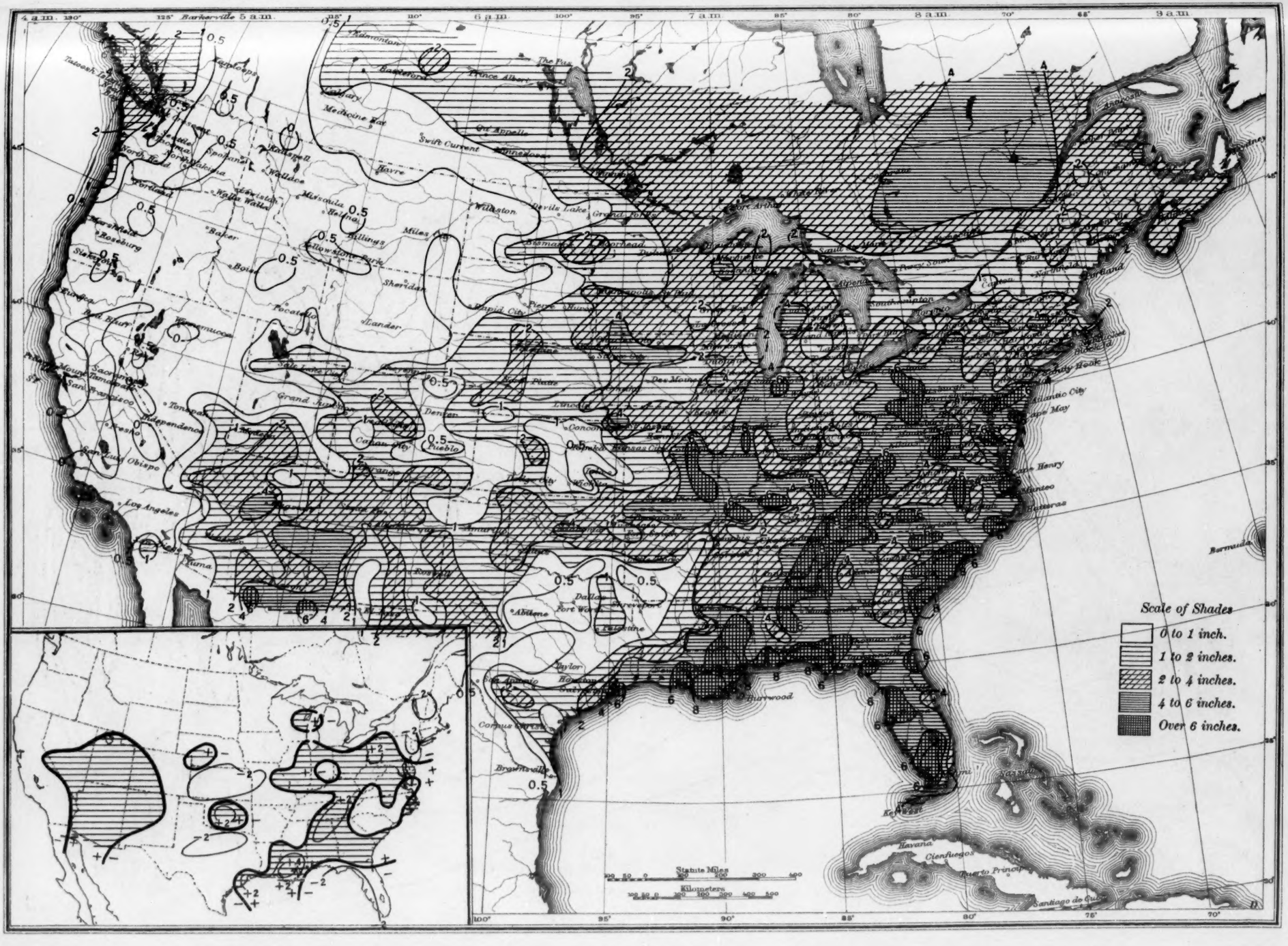

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Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, August 1934

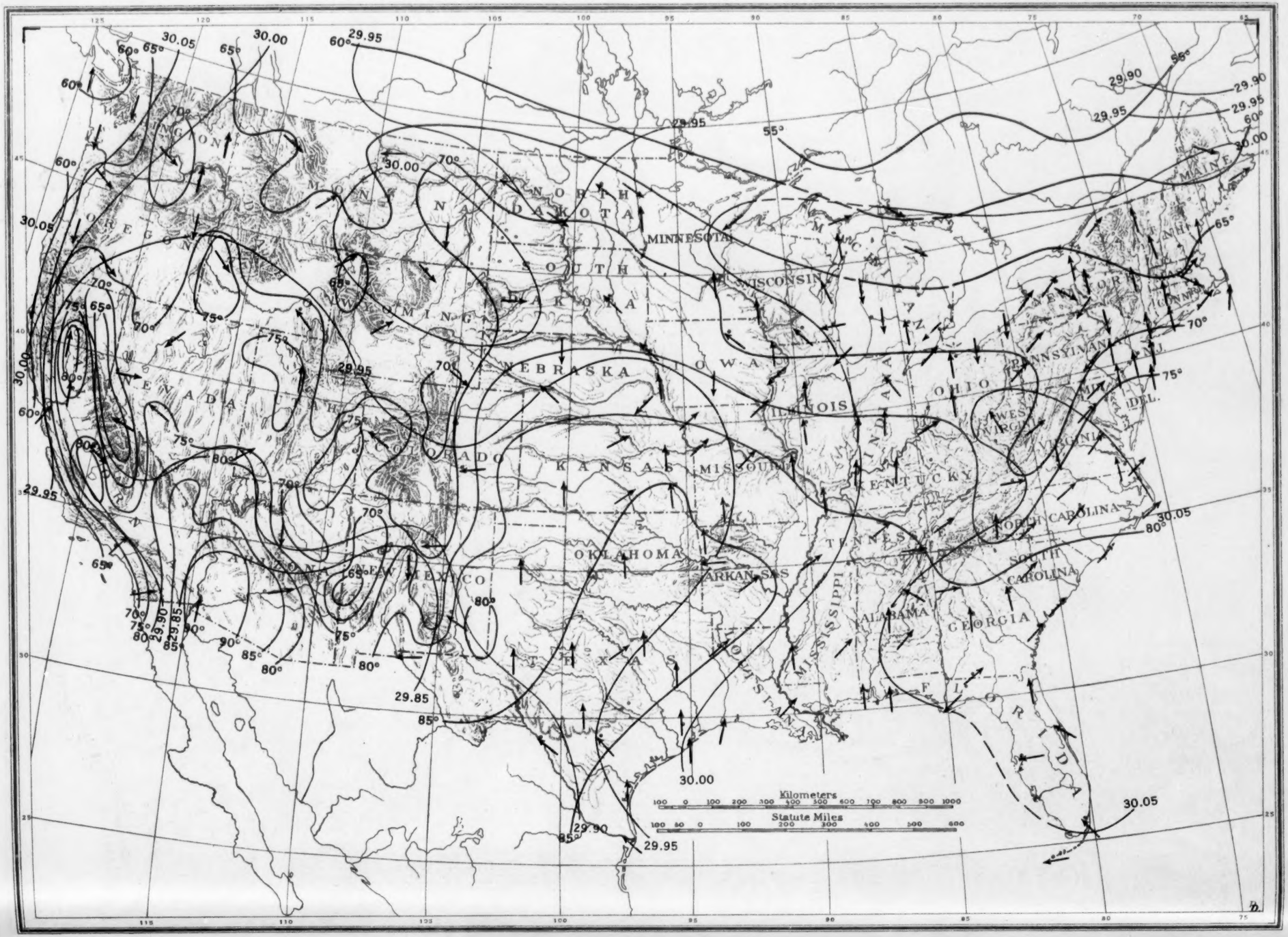

Chart VIII. Weather Map of North Atlantic Ocean, August 8, 1934

(Plotted from the Weather Bureau Northern Hemisphere Chart)

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(Plotted from the Weather Bureau Northern Hemisphere Chart)

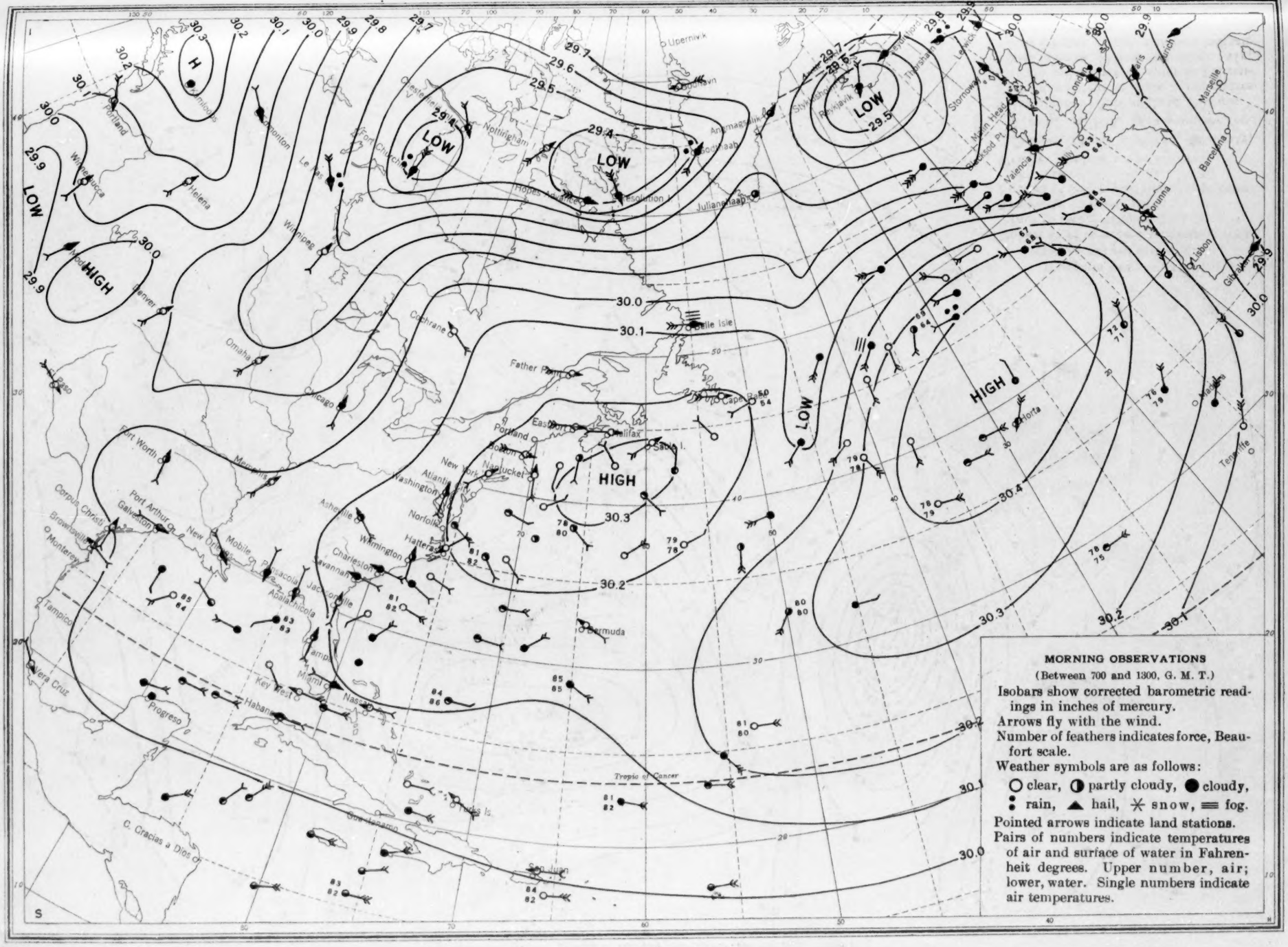

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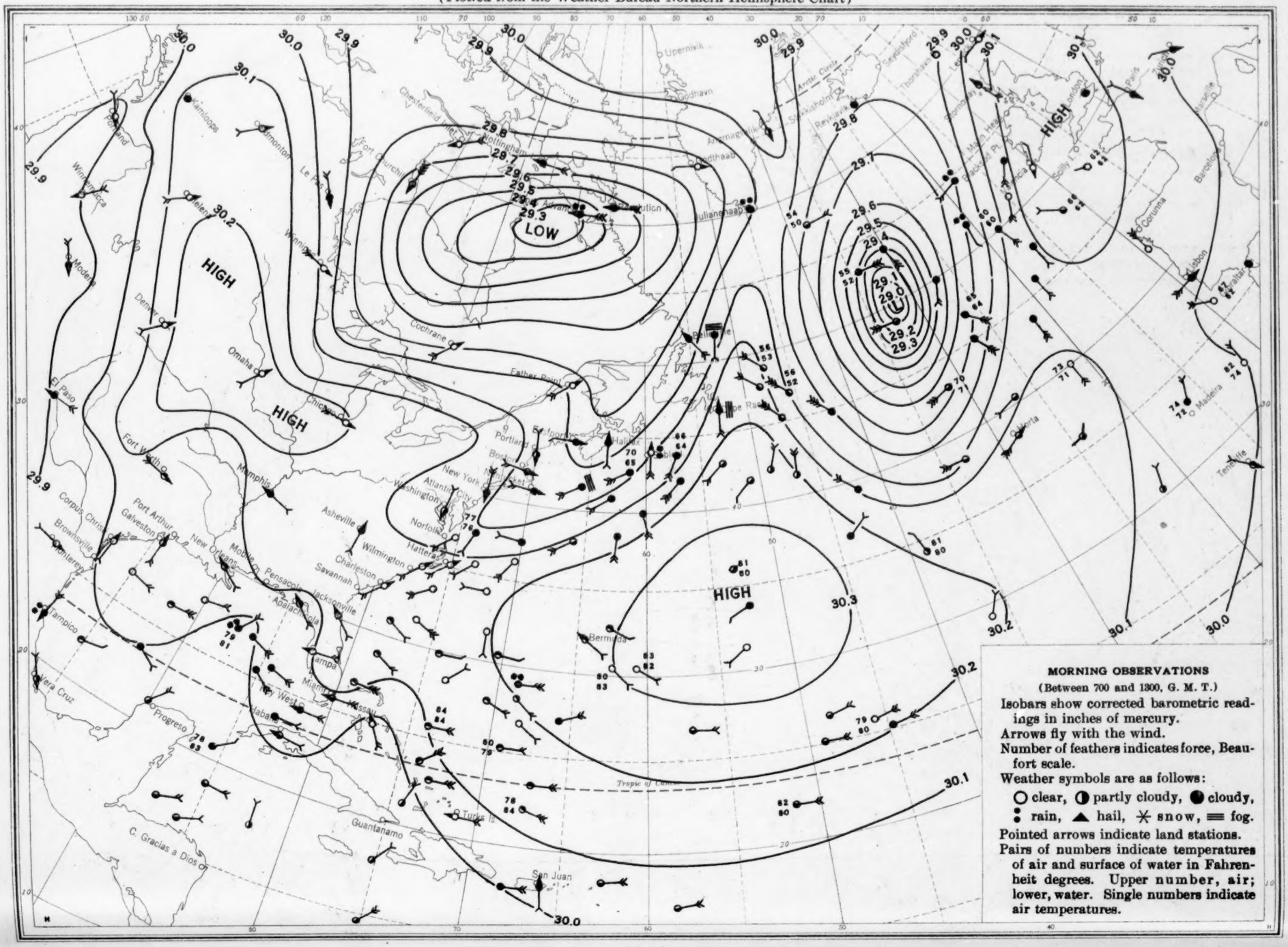
Chart IX. Weather Map of North Atlantic Ocean, August 25, 1934

(Plotted from the Weather Bureau Northern Hemisphere Chart)


LOW
HIGH
HIGH
HIGH
HIGH
MORNING OBSERVATIONS
(Between 700 and 1300, G. M. T.)
Isobars show corrected barometric readings in inches of mercury.
Arrows fly with the wind.
Number of feathers indicates force, Beaufort scale.
Weather symbols are as follows:
clear, partly cloudy, cloudy,
rain, hail, snow, fog.
Pointed arrows indicate land stations.
Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.

SEVERE LOCAL STORMS, AUGUST 1934—Continued

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Salt Lake City, Utah	29				2,000	Electrical	6 houses in widely separated parts of the city struck by lightning.	Official, U. S. Weather Bureau.
Creston-Howell, Nebr	30	3-4 p. m.			50,000	Hail	Hailstones large; property damaged	Do.
Valentine, Nebr	30	3:30 p. m.	[1] 1		15,000	do	Hail to depth of 3 inches remained unmelted on the ground in spots for 24 hours; gardens totally destroyed; poultry killed; wild birds killed or crippled; most severe hailstorm of record in this community.	Do.
Fremont, Nebr	30	4:30-5 p. m.	[1] 5		4,000	Wind	2 persons injured; no details	Do.
Grafton, Nebr	30	4:50 p. m.	[1] 10		10,000	do	No details	Do.
Trego County, Kans	30	6 p. m.	300		5,200	Tornado and hail	Damage to barns and small buildings; 2 persons injured; path 8 miles long.	Do.

SEVERE LOCAL STORMS, JULY 1934 (SUPPLEMENTARY TABLE)

Cumberland (near), Md	7	4 p. m.			8,000	Electrical	Barn and contents struck by lightning and burned	Do.
Kitzmiller, Deer Park, Accident, and Swallow Falls, Md.	22	7 p. m.	[1] 20			Heavy hail	Considerable damage reported; chickens killed, roofs damaged, and windows broken.	Do.

[1] Miles instead of yards.